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# Proceedings
# of the
# NAVAL STORES WORK CONFERENCE

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Held at Gainesville, Fla.
October 19 and 20, 1964

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

# PREFACE

The USDA's Agricultural Research Service wants to assure that the Nation will receive maximum benefit from its research programs. Utilization research is constantly developing new ideas and products which show great possibilities of benefitting growers, industry, and consumers.

This conference was jointly sponsored by the Southern Utilization Research and Development Division of ARS; the American Turpentine Farmers Association; Pulp Chemicals Association, University of Florida's School of Forestry; University of Georgia's School of Forestry; and the Southeastern Forest Experiment Station, Forest Service, the Agricultural Stabilization and Conservation Service, and the Agricultural Marketing Service, USDA. The purpose of the conference was to acquaint representatives of the naval stores industry with current developments in research, production, and marketing, and to provide for an exchange of information that will benefit future research.

Included in this proceedings are copies of the papers presented at the conference. Because of regrettable circumstances on the part of the recorder of the discussions, no copy of the discussions or of the presentations of the panelists is available.

*Mention of companies or products used in this publication are solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U. S. Department of Agriculture over others not mentioned.*

*Underscored numbers in parentheses refer to references placed at end of each paper. The data given in the references are essentially those forwarded by the writer.*

*The figures and tables are reproduced essentially as they were supplied by the author of each paper.*

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# PROCEEDINGS OF THE NAVAL STORES WORK CONFERENCE HELD AT GAINESVILLE, FLA. OCTOBER 19 and 20, 1964

Judge Harley Langdale, Honorary Chairman
John R. Durland, General Chairman
Ray V. Lawrence and Downing Musgrove, Cochairmen

## Opening Session

### INTRODUCTORY REMARKS

by

C. H. Fisher, Director
Southern Utilization Research
and Development Division

I wish to say "Good Morning" and "Greetings" to this splendid audience.

I am not on the program but Bruno H. Wojcik, who had a major role in planning this conference, asked me to make three introductions.

I am the first of the three. My name is C. H. Fisher, and I am with the Southern Utilization Research and Development Division, in New Orleans, of the Agricultural Research Service, U. S. Department of Agriculture.

The next two are so well known that they need no introduction.

I refer to our Honorary Chairman and General Chairman who are admired throughout the Naval Stores Industry.

We are pleased, and we are honored because a great man--the President of the American Turpentine Farmers Association--is our Honorary Chairman.

Judge Harley Langdale. Will you take a bow, please!

We are fortunate and grateful because John R. Durland--President of the Pulp Chemicals Association--will serve as our General Chairman. This in itself speaks well for the success of our Conference.

### WELCOME

by

J. W. Reitz, President
University of Florida - Gainesville

Dr. Durland, Congressman Matthews, Judge Langdale, and distinguished guests: It is indeed a pleasure to welcome members of this conference on Naval Stores Work to the University of Florida. The Southern Utilization Research and Development Division of the Agricultural Research Service of the United States Department of Agriculture is to be complimented on garnering such an array of sponsorship. Here is an illustration of the effective blending of talent of the United States Government with private industry as represented by the American Turpentine Farmers Association and the Pulp Chemicals Association, along with two publicly supported schools of forestry and the Georgia Forestry Commission. We are indeed pleased that you chose the University of Florida as your site for this conference.

I need not remind this audience that forestry and forest based industries and activities are of tremendous importance to Florida as they are also to Georgia and other States represented here.

We have about three-fifths of our land area in forest cover. About 90 percent of our forests are in private ownership. We are heavy producers of slash and longleaf pine timber and timber products, with one-half of our forest area in these highly resinous pine species. They, of course, form the basis for gum naval stores and wood naval stores segments of your industry and, in the naval stores belt, provide a large proportion of the raw wood requirement for the sulfate pulping industry.

Although we now rank a very poor second to Georgia in that historic southern enterprise known as "gum farming," we supply half of the stumpwood tonnage now used annually by the wood naval stores segment of the industry. In 1961 we had a greater inventory of operable old growth longleaf and slash pine stumpwood than any other state. In both the gum and wood naval stores segments we have adequate raw material bases for expansion when marketing and economic conditions make such expansion attractive.

In manufacturing, 2 of the 20 gum naval stores processing plants in the United States, 4 of the 13 wood naval stores steam distillation plants, and 2 of the 12 tall oil fractionation plants are located in Florida.

In sulfate pulping, we have 8 major mills with a total daily capacity of 7,900 tons and tank second only to Georgia nationally in such capacity.

In research, the Olustee Naval Stores Laboratory of the Southern Utilization Research and Development Division and the Lake City Center of the Southeastern Forest Experiment Station are just 50 miles from this campus. Our own Forestry School has been deeply involved in the selection and breeding of high gum yielding varieties of slash pine.

John Gray will touch on the interest and activities of our Forestry School in naval stores. Beyond forestry, at this University we are thoroughly involved in the training of chemists, biochemists, and chemical engineers as a continuing source of professional manpower to your industry.

This may be enough evidence to convince you of the extent of our interest and involvement in this conference and of our stake in the success and strength of the naval stores industry. We are delighted that you are here. We want to find out through our contacts with you how this university can be of greater service in the naval stores field. We hope you will have a profitable and pleasant conference and invite you to use our facilities at any future time for meetings of this type.

## OPENING REMARKS

by
Honorable D. R. (Billy) Matthews
U.S. Representative
Washington, D. C.

I want to thank the planners of this meeting for inviting me to appear before this Naval Stores Work Conference. No one who has reviewed the agenda of this Work Conference Program can help but be impressed by the wide range of significant study topics and the high caliber of people who will lead and participate in the discussions.

Here in this program we see a fine example of government and private enterprise working side by side and of the research scientist and the man who applies the "new know-how" talking the same language. We also see an industry boldly taking that cold hard look at itself in order to fathom the future. What we are really looking at is a great example of American democracy in which the producer, the processor, the distributor, the research scientist, and the industrial consumer have teamed up together. I subscribe to this approach wholeheartedly and congratulate you.

After a long and arduous session in 88th Congress, I can assure you that it is a delight to be home. It's good to be away from the unending pressures of national and international issues and once again to find time to visit with the folks in my home District. It is especially gratifying to discuss their problems with them and to hear them relate their aspirations for their children, themselves, their county, city, state, and their country. To a Congressman this is vitally important. It permits him to keep tuned to the needs and desires of the people of his district and his State, and in this way, it enables him to better serve the Nation.

In 1952 the people of my district elected me to Congress. Since then I have served six successive terms. During those 12 years in Congress, it has been demonstrated to me, time after time, that our national goals are best served when the aspirations of the individual are successfully met. And although our place in the world today places a high premium on our national goals, these are in reality a composite of all our goals--yours and mine; big and small; rural resident and city man; white collar and blue collar worker--every one counts.

Let me illustrate: Millions of Americans across this Nation use rosin and turpentine. Yet, I doubt if there is one user in a thousand who gives the slightest thought to the land and trees from which it came and to the people in this room who researched it, produced it, processed it, and distributed it. But, let us suppose that you quit producing the rosin and turpentine that flows into our homes and factories. Once the shelves were bare there would be a sudden interest in the source of the product and the people who produce it and substitutes for it.

I guess what I'm trying to say is that the naval stores industry occupies a vital spot in our national life. The men and women in this room and their coworkers, in their own quiet way, are seeing to it that the national demand for rosin, turpentine, and all other naval stores products is met day after day.

This has not been easy. Like every other business naval stores has had its ups and downs. But I believe that in all the 300-year history of the gum naval stores business in America, 1936 will be remembered as the year when the big turn was made. That spring the American Turpentine Farmers Association came into being. That summer, largely through the efforts of the Association, the Naval Stores Conservation Program was born. It was then, as it is today, a voluntary program--no one can force you to participate. The U. S. Department of Agriculture's Forest Service was designated as the administering agency along with the predecessor of the Agricultural Stabilization and Conservation Service cooperating.

Working hand-in-hand with research scientists of the Forest Service, the Agricultural Research Service, and the South's colleges and universities, with the industry and woodland owners, USDA's Cost-Sharing and Price Support Naval Stores Conservation Program has consistently moved forward. Starting in 1938 with a requirement setting a minimum diameter limit on trees eligible for cost-sharing, we have seen the introduction of acid stimulation to increase gum yield and a reduction in number of visits to trees from weekly to biweekly. We have seen bark chipping and use of easily removable double-headed nails accepted as the way to make the butt log merchantable after the tree is worked out. We have also seen new market outlets for naval stores products developed through USDA's utilization research. We have seen the wood-fired still replaced by the centralized steam distillation plant, and we have seen better hardware developed and accepted.

And now our naval stores scientists are working on even newer production techniques involving the use of 2, 4-D and looking to the day when visits to the tree can be cut from 26 per year to 9 or less. Just think what that will mean in labor savings, lower production costs, and higher net profits. New uses are also in the making for naval stores products in the aromatic field and as a raw material for the plastics industry. Still another bright light in the business is genetics research which has developed strains of trees that will produce twice the average yield in gum; or, saying it in other words, gum at half the present labor cost. Research on a common weed-killer, 2, 4-D, as a replacement for acid stimulation in slash pine forests shows promise of some increase in volume of gum but most important it is producing rosin in greater volumes of the high grades which far exceed those produced by acid stimulation. And now to top it off, the Forest Service is experimenting with the development and use of 2, 4-D in a handy paste formulation.

You know your industry has a fabulous conservation story to tell. I wish all Americans were acquainted with it. So many of our people, even those who live in the naval stores area, are not aware of the fact that to the successful gum farmer gum is not the end product. Wood is the end product. Gum production is carefully tied into wood production and can double or even triple the profit from the forest. And, now rapidly coming on the scene are techniques for producing even more multiple use products from woodland in order to increase the income of the landowner and improve his chances for a fair return on his investment. In this connection, I might say that the Secretary of Agriculture has asked the Chief of the U. S. Forest Service to develop a long-range National Program for State and Private Forestry. It will be a multiple-use, sustained-yield program. I consider this an important step forward, a step which is destined to help your industry and all the woodland owners of America. Congress is interested in this program. I feel certain that it will receive its closest attention.

I feel certain that the Naval Stores Conservation Program is here to stay. It is here to stay because it is in the national interest. The program buys time for the woodland owner which permits him to give his trees those additional years of growing time because it enables him to earn an annual income from his woods. In the woods of our Naval Stores Conservation Program supervisor, Norm Hawley, "Naval stores enable the woodland owner to collect his second payday, first."

The Naval Stores Conservation Program is a cost-sharing program and although the Federal share is only 5 to 10 percent, this share, as small as it is, has been a major factor in creating great interest in and adoption of good forestry practices in the naval stores belt. Thanks to your industry, today we have wood when we want it, and in sizes we want, all through the Belt, and we have quality naval stores too.

Although most of the things I've said are gum oriented, I am convinced that much of the new development, today and still to come, will benefit wood naval stores as well.

I want to wish you every success in your deliberations at this Work Conference, and thank you for the privilege of participating.

# INTRODUCTION TO PROGRAM AND PLANS OF THE SCHOOL OF FORESTRY

by
John Gray, Director
School of Forestry
University of Florida
Gainesville

Judge Langdale, Dr. Durland, Dr. Fisher, Congressman Matthews, Dr. Senti, President Reitz, Ladies and Gentlemen: On behalf of the faculty, staff, students, and alumni of the School of Forestry, University of Florida, let me tell you how much we have looked forward to this day and how delighted we are to have you and the 1964 Naval Stores Work Conference on this campus.

Let us start out by being honest with one another--quite frankly we angled a bit to have this conference held here this year. We had several objectives in doing so. First, we wanted to make sure that you knew where we were located in Florida.

Before coming here, I was connected with the Agricultural Extension Service and School of Forestry at Raleigh, N. C. Every time I met someone from another State, the conversation would go like this:

"Mr. Gray, who are you with?"

"I'm at North Carolina State."

"That's wonderful. Chapel Hill is a beautiful town."

"No, no--I'm at N. C. State in Raleigh."

"Oh, that's right. The University is at Chapel Hill."

Now here in Florida, we have four State senior universities--Florida State at Tallahassee, Florida Atlantic at Boca Raton, South Florida at Tampa, and Florida at Gainesville. With all due respect, however, in Florida the University is at Gainesville. The School of Forestry is part of the University at Gainesville and is proud to be so affiliated.

Our main purpose in bringing you here was to let you see and, we hope, be impressed by the University of Florida, knowing that if you are impressed by it, you must likewise be impressed by the potential here for strong programs in forestry training research and Extension. For forestry today is an applied science built on foundation sciences such as mathematics, statistics, economics, chemistry, biochemistry, physics, biology, botany, geology, and soils.

In addition, today's professional forester, like a professional in any field, must understand and be understood by the highly organized, pluralistic society whose natural environment and consumption pattern he helps to shape. Thus his preparation requires a solid grounding in English, and in history, political science, and the arts which have determined the culture of his time. All of these fields, we are happy to say, are strongly represented in this University.

Our second reason for asking you to come was this. Dean Al Herrick and his people at the George Foster Peabody School of Forestry, University of Georgia, have done such a fine job over the past several years, and his alumni are so enthusiastic about that school, that we felt it was absolutely necessary to get you here to make sure you knew that there is an accredited professional school of forestry south of Athens.

In our School of Forestry, we currently offer professional training leading to both the Bachelor of Science and Master of Science in Forestry Degrees in forestry, and in the two closely related fields of wildlife management and forest products technology. Currently, we do not offer a PhD. within the school itself. Through the Departments of Agronomy, Botany, and Soils, with whom we enjoy excellent relationships, we train men at the doctoral level in forest genetics, forest tree physiology, and forest soils.

In research, we have for some 10 years been engaged in a cooperative forest genetics research program which is partly financed by nine major pulp and paper companies. This program is now well into the progeny testing stage on a large scale. In cooperation with the Department of Soils, we have some large-scale studies going forward in tree nutrition and the use of fertilizers. Early in 1965, we will be embarked on a new research and graduate training program in our own School in forest tree physiology--particularly the physiology of slash pine--flower formation, cone and seed development, nutrient requirements, and use in such mechanisms.

Our main assets for making a worthwhile contribution to professional training and research in forestry and related fields are:

Our location in a large university with high academic standards.

Our location in the second most rapidly growing State in the Union.

The interest and support of a large number of imaginative industry and public forestry program leaders.

The support of a loyal body of forestry alumni.

Ready access to a fine teaching and research facility in our 2,000-acre Austin Cary School Forest located just 20 minutes from our campus.

A philosophy akin to that of the late Cardinal Newman when he said that "Growth is the only evidence of Life."

Our last reason for urging the powers that be to locate this conference here was a personal one. I have many friends located in Georgia and Alabama.

(After reviewing arrangements for the Conference Mr. Gray concluded with the following--)

Once again we are delighted to have you here. Let us know if there is any way in which we can make your stay both profitable and pleasant.

## UTILIZATION RESEARCH IN SOUTHERN AGRICULTURE

by
F. R. Senti
Deputy Administrator
Agricultural Research Service
United States Department of Agriculture
Washington, D. C.

It is indeed a pleasure to participate in this conference and to become acquainted with the people of the naval stores industry. I hope that I will have additional opportunities soon of traveling in this region to become better acquainted with the Southeast and to visit with agricultural and industry leaders.

This morning I would like to review briefly the role of utilization research in the American agricultural economy. I also wish to discuss briefly our plans for new laboratories to be constructed soon in Georgia and Florida. I am referring to the new Southeastern Regional Research Laboratory planned for Athens, Ga., and the construction of additional facilities for research on utilization of naval stores at Olustee.

Although this audience has long been familiar with utilization research, I would like to speak briefly of the organization and the objectives of this work. Utilization research in the U.S. Department of Agriculture is directed to the development of new and improved processed products from the commodities of the farm. Its purpose is to provide new or extended markets from which producers will derive increased returns. It is a major project of the Agricultural Research Service. The work is carried out through our four Utilization Research and Development Divisions, each of which is centered at the corresponding Regional Research Laboratory. Our work on naval stores at Olustee is a part of our Southern Division. Each of our divisions has made contributions to agriculture in which we take great pride and satisfaction.

Back in the midforties the production of oranges here in Florida had reached an annual rate of 50 million boxes, with prospects of further increases in production but little outlook for increased markets. Department scientists at Winter Haven, in cooperation with the Florida Citrus Commission, developed the basic process for making frozen orange juice concentrate. Less than 20 years later, the production of about 60 million (1963-64) gallons of concentrate required more than 60 percent of the Florida crop--a fresh fruit value of around $180 million. This development has done much to stabilize the income of citrus growers. We are working now on an economical process for reducing the juice to a powder which would have significant advantages in the export market.

Cotton was about to be swamped in some of its major markets by mounting waves of synthetic fibers until utilization research developed wash-wear cottons. Now more than 1 million bales of American cotton go into these products each year. Our process for manufacture of all-cotton stretch fabrics is just being commercialized. They may very well prove to be as great a boost to cotton markets as the wash-wear fabrics. Already they are finding favor in clothing, slip covers, and other markets where the qualities of cotton are most desirable and the stretch characteristic most attractive. Cotton research is being challenged by research on other fibers, such as dacron, nylon, and rayon. Great strides are being made in improving end-use properties of these manmade fibers. And we in Utilization Research cannot afford the luxury of complacency.

Utilization scientists have devised a method for making wool shrink resistant. Employing the new technique of interfacial polymerization, the treatment results in the formation of an invisible film firmly attached to the surface of the fibers. The reaction occurs rapidly, requires no curing, and neither weakens nor harshens the fibers. Wool fabrics treated with the new finish retain both their original texture and color, and the process is compatible with other treatments developed by the same group to give wool permanent creases. Garments made from fabrics given the new treatment are shrink resistant and muss resistant. They are largely unaffected by laundering and drycleaning.

Another area in which new outlets were needed is that of animal fats, displaced from traditional soap markets by synthetic detergents. Utilization research has developed outlets for about 700 million pounds of these fats a year in processed feeds alone. Cooperative research with industry and others showed that all grades of animal fats could be used in feeds. The fats not only have nutritional value, but also reduce dustiness and improve the color of the feeds. Other outlets have been developed in water-base paints, plastics, waxes, adhesives, and other industrial products. Interestingly enough, it appears that animal fats may find their way back into the soap and detergent field as a result of our search for a biodegradable detergent that will break down completely in normal sewage treatment. Our animal fat project, incidentally, is responsible for the epoxy plasticizer stabilizers now used extensively in vinyl plastics.

Dialdehyde starch, one of our developments from grains, is finding substantial use in the manufacture of wet-strength paper. It shows great promise of finding major application in plywood glues adapted to your Southern pine industry. The wood differs as you doubtless know from that of the Douglas fir in its adaptability to adhesives. We are hopeful that our modified starches and cereal flours will find expanding use as sizes and coatings in the paper industry, and that cereal pulp prepared from flour by xanthation will find an important place in the paper industry, particularly as a component of various kinds of paperboard. It contributes to dry-strength as well as to wet-strength at costs we are confident will prove favorable.

The increasing importance and shifting character of your Southeastern agriculture has been recognized by the Congress in making available funds with which to construct our new Southeastern Laboratory at Athens, Ga. This will be the headquarters facility for our new Southeastern Division. It will be a substantial installation patterned after the other four whose basic designs have well stood the test of 24 years' heavy duty. It will provide 96 laboratories with pilot scale or "high lab" facilities to carry out developments on a semiworks scale. The evident trend of your agriculture to increased production of forage, poultry, livestock, oilseeds, fruits, and vegetables dictates major programs looking to improved uses for these crops but the program at Athens will not necessarily be limited to them. We are pleased that we will be located in the University atmosphere and have access to the University library and other facilities. And especially, we look forward to pleasant and profitable neighborly association with the University people.

But, to you as representatives of the naval stores industry, I wish especially to report that the Congress has provided for construction and renovation at our Olustee station that together with the laboratories just occupied will double our capability there. We trust this will result in a proportionate stepping up of our output of useful information. You are all familiar with the many accomplishments which have come from the Olustee station, and you are aware that the Olustee station publishes many papers containing basic information of value to the industry in developing new products. Their accomplishments include gum cleaning process, steam distillation, and standardized purchasing procedure which led to the nearly universal control processing system. From Olustee, too, have come the pinane and menthane hydroperoxides that have proved to be superior catalysts in the manufacture of "cold" rubber. New metal resinates, containing a higher proportion of combined metal than other fused resinates, that is more soluble and with greater resistance to oxidation are being evaluated as paint driers, wood preservatives, special soaps, and corrosion inhibitors.

Recent products developed by utilization scientists at Olustee include plasticizers and chemical intermediates from pinic and pinonic acids, alkyd resins from an acid made by treating pine gum with fumaric acid, and other raw materials useful in plastics and synthetic rubbers.

You will hear more of our current strong program as the conference proceeds. It is aimed directly at producing from gum constituents new products of greater value through a number of promising chemical approaches.

Beyond our own laboratories, research is in progress under contract at the University of Cincinnati, Cincinnati, Ohio, on the application of the oxo and related reactions to terpenes and resin acids to produce new, useful alcohols, aldehydes, and/or acids; at Cornell University, Ithaca, N. Y., on the synthesis of terpene alcohols and glycols for use in the production of new and useful terpene-derived polymers; and at the University of Florida, here at Gainesville, on the development of a practical process for the conversion of $\alpha$-pinene to dimers in good yields, and the conversion of these dimers to useful, reactive derivatives.

Research in the field of chemical composition and physical properties is in progress under a grant of Public Law 480 funds to the Juan de la Cierva School of Technical Investigations, Barcelona, Spain, for development of new or improved methods of preparing selected terpene alcohols, and to obtain basic information on the composition and properties of products made from pine gum.

More and more we find that current problems call for new knowledge, often in areas where man has never ventured before. Such fundamental information comes only from basic research that probes deeply into why and how things happen. For this reason we are steadily stepping up our basic research. In 1950 basic research was nearly 13 percent of the research effort in the Department of Agriculture. By 1964 more than 31 percent of the Department's research is in basic studies. We look forward to putting 50 percent of our research effort into this quest for new knowledge.

To help us better coordinate our utilization research efforts, we have recently combined our Nutrition and Consumer Use Research with Utilization Research to form one unit--Nutrition, Consumer, and Industrial Use Research. We will have a better planned and more effective program under this new arrangement. As more of our total resources are focused on consumer needs, there is greater assurance that consumer preferences will get the proper attention.

Utilization research has made and is making widely varied contributions to the economy. In its 20-odd years of operation, USDA utilization research has added more than $2.5 billion to the value of farm commodities at a research cost of less than $175 million. That is a relationship of benefits to costs of nearly 15 to 1. Each year the return has increased as more results of our research are put to work by American industry. During the past 5 years, the benefits-to-cost ratio has jumped to 25 to 1.

We continue to move ahead in utilization research--changing our patterns of work to reflect the needs of the American public--always keeping in mind our basic aim of converting imaginative ideas into practical processes and products. We are confident that our past successes will be multiplied in the future.

## Session I--Production
V. V. Lindgren, Chairman

# MANAGEMENT OF WOODLANDS--BROAD POLICIES IN NAVAL STORES PRODUCTION

by
B. E. Allen
Woodlands Division
Union Bag-Camp Paper Corporation
Savannah, Ga.

(Presented by W. J. Barton)

It is a pleasure to participate in this Naval Stores Work Conference and to discuss with you the place of gum production in the management of Union-Camp's Savannah Division Woodlands. All of us concerned with the management of our company's forests have enjoyed many long and pleasant associations with gum operators and processors throughout the naval stores belt. It is also significant, I think, that Union-Camp is involved in all of the three major segments of the naval stores industry: from stumps--to streaks--to tall oil. Our association with people who represent the many facets of a fascinating industry has been a very rewarding experience to us. Indeed, many of our foresters gained much of their knowledge of the lands and the people of the area from the oldtime naval stores operators.

Our organization became active in land acquisition with the start of the construction of our Savannah plant in the midthirties. Many of our properties were acquired from naval stores operators or landowners interested in turpentine operations. Several tracts were purchased subject to long-term naval stores leases. These contracts were honored, of course, and operations continued after our acquisition of the property. On other acreage, where profitable working faces existed, arrangements were made for continuing going operations or for initiating new operations. Very early in the management of our forest lands we developed an appreciation of both the advantages and disadvantages of streaking the living pine. It has always been our belief that the hack, dip barrel, and distillation still are compatible with our primary objective--that of insuring via ownership of tree farms the continuing profitable operation of the world's largest pulp and paper plant by supplying a portion of its wood requirements.

It follows, then, that our primary concern is the production of wood fiber; however, our interests are not limited to pulpwood. We are active, and modestly we feel a major factor, in all wood product markets within our operating territory. Briefly, we sell between 35 and 40 million board feet of pine and hardwood logs and about 120 to 125 thousand poles and piling each year. Indirectly this is enough to run a medium-size creosote plant. The leasing of faces fits well, and holds a prominent place, in our multi-product concept of forest management and product merchandising.

Perhaps to set the stage for our review of tree farming--Union-Camp style--it would be appropriate to review with you our forest management program and explain to you how turpentine operations are integrated into our system of land management. As our Corporation acquired forest properties, they were grouped into 10 local operating units of approximately 100, 000 acres each, that we call forests. Our early efforts were directed toward the establishment of initial protection, primarily from fire and illegal trespass. During this phase, we also engaged in basic programs necessary in the development of a forest property. A good example would be the construction and improvement of a road network designed to provide all-weather access for fire protection and timber removal activities.

During the early 1950's, it was apparent that our initial efforts were reasonably successful and it was recognized that a more formal management plan was needed. A planning framework was developed which provides a programming base that insures continuity of forest operations and progress toward our ultimate goal of optimum production of a variety of forest products plus ample supplies of raw material for our Savannah plant.

As a result of our considerations, we adopted an area control regulatory system of both timber management and all other associated forest management activity. We decided that for our particular and specific conditions, based on the silvical characteristics of our primary species--slash pine--to build our working concepts around a 30 year rotation. We introduced 5 year treatment and/or cutting cycles or both for timber management purposes as being best suited to our woodland holdings.

To facilitate the handling of our land administrative responsibilities, the 10 forest units were grouped into three districts. The individual forests were divided into working circles of approximately 30, 000 acres each and the working circles were further subdivided into compartments of approximately 1, 000 acres each, or 30 compartments per working circle. Easily recognized topographic features such as roads, streams, or property lines were used as compartment boundaries and compartment size was held to as near 1, 000 acres as practical. Each compartment was assigned a number from 1 to 30, which designated its chronological position in the working circle for treatment and cutting, or both. The number assigned to the compartment depended upon the age and condition of the major stand or stands within the compartment. As an example, those compartments supporting the oldest stands most in need of cutting were given low numbers indicating that major treatment would be given very early during the first rotation. Those compartments recently cut, and supporting stands of young reproduction or young plantations were given higher numbers indicating a harvest cut relatively late during the first rotation. All management planning is now at the working circle level and on a compartment basis. Every 5 years each compartment is examined for thinning or for some other forest management activity necessary to maintain or promote optimum growth or economic advantage. This, in effect, is a 5 year inspection and treatment cycle which is the heart of our plan. Generally, on each 30, 000 acre working circle, naval stores chances are uppermost in our minds when we examine a compartment scheduled for harvesting 5 years hence. This means that there is a possibility of initiating an operation on one 1, 000-acre compartment annually for each working circle. This translates further that for each 30, 000-acre working circle there is a possibility, under full production, of having naval stores operations on four 1, 000-acre compartments during any given year. You will recognize that arithmetically the numbers add quickly under full management to a potential of 120, 000 acres of faced trees, if you accept that we own and control about 900, 000 acres of pine land.

Through the execution of this program there were 65 crops of naval stores faces on our lands during 1959. As market conditions appeared favorable, we increased our naval stores operations to approximately 190 crops in 1961. We have continued to emphasize naval stores and have made every effort to work all available chances. We now have about 225 crops on Company land which will drop off in 1965 to about 190 crops. These statistics give some indication of our present involvement in the gum resin industry.

Turpentine chances on Union-Camp are generally worked for 4 full years. At the end of the fourth year, cups, hardware, and nails are removed from the trees leaving us a compartment with all 9-inch D. B. H. (diameter at breast high) and larger trees with faces of from 6-1/2 to 7 feet high.

Our next effort is directed at merchandising the tree for its best use and highest economic gain as soon as possible in order to minimize possible damage by fire or other mortality-producing agents. Since poles normally offer the greatest return per unit volume of timber, the possibility of a pole operation is given first consideration. Although the American Standards Association considers naval stores faces in poles as scars, 4 feet of face is acceptable. Even with this handicap, we sell as many faced trees as possible as poles. After the poles are removed we sell the sawtimber, which is not affected by the face. The sale of the remaining pulpwood to an independent wood supplier is the last major operation connected with the standing timber on a given area. The residual stems too small for pulpwood are frequently sold for posts. Finally, rosin producing stumps are removed by a company interested in that phase of the industry. You see we start with a fully stocked forest stand and when we finish our merchandizing and utilization efforts, all we have left is a few stump holes in the land plus, hopefully, a nice fat profit margin on the Profit & Loss Statement.

The harvesting of the products from an area is closely followed by mechanical site preparation with the degree of intensity dependent upon the specific needs of the site. The prepared areas are planted with quality seedlings grown at Union-Camp's Bellville Nursery. The resulting stands will, if our present plans hold, support a naval stores operation in 25 years. Thus, we complete the full cycle of forest management and growth with naval stores playing a most important, useful, and profitable part in the overall land management program.

We would not want to leave you with the impression that a naval stores program just happens, that all one must do is "put out the word" and, presto, operators beat a path to the door and 225 crops magically appear on the land with Waterwhite only pouring forth. Actually, our 225-crop plateau has been right hard to come by. Since our 1,100,000-plus acres of land are located all the way from Canady's Crossroad in Colleton County, S. C., to Deland in Volusia County, Fla., we have had to hunt acceptable operators in a number of areas. They are not easy to find. We always seem to have the problem of a number of good operators where we have a scarcity of timber and only a few good operators where we have timber in abundance. We have a considerable problem making our timber chances fit available producers, but we feel we have the very best operators in the belt working on Company lands.

Each summer we determine the number of virgin crops we will have available for hanging the following winter. By doing this, our old established operators know well in advance what they can expect. Each year we have a few new operators hanging virgin on us. We spend as much time as is necessary with these men so as to make sure they understand our requirements. During the fall contracts are negotiated and "understandings" are reached between ourselves and the operators. After verbal agreements are made, formal contracts are drawn and executed. Union-Camp's field personnel, all experts and almost artists, prescribe burn the proposed naval stores area at Union-Camp's expense. We try to get this done in the late fall or early winter since most operators prefer to hang virgin right after Christmas.

Our foresters keep a close eye on all operations. We establish a good working relationship with the operator and his woodsrider or supervisor, fully recognizing his undisputed status as an independent businessman and entrepreneur. We do not hesitate to point out contract discrepancies and offer constructive criticism. We ask that corrective action be taken where contract stipulations are overlooked. If you want to see an upset Union-Camp forester, you'll find one who has just discovered that a streak has been missed in July on a couple of his drifts. This does happen and he knows it is a loss to both parties of the contract that can never be recovered.

We of the Woodlands Division of Union-Camp are solidly in favor of streaking our trees for naval stores. While such operations increase our exposure to fire and insects, withdraw large volumes of trees and timber from cutting plans for relatively long periods of time, and reduce total fiber increment, there are a number of advantages that so far have outweighed these major disadvantages. As we see it, they can be capsuled as follows:

1. Streaking our trees generates income to the company treasury. This is extremely important in that continually mounting annual costs, including ad valorem taxation, dictate that maximum income from each forest acre be realized.

2. Naval stores operations aid in identifying our organization with resident landowners and help to make us more a part of the community. This adds up to good public relations, fire prevention, and protection.

3. Working trees is a good stimulant to local rural economy in that it provides employment for a number of local people whose money is spent at home. We believe it is a contradiction to the occasionally expressed onus of large corporate ownership.

4. We, as essentially pulpwood people, feel we are cooperating with a brother market. This concept is important to the continued profitable management of our only renewable resource as the major raw material for a number of industries throughout the South.

5. Our entry into the processing field through our Nelio acquisition serves to strengthen our interest in gum production on corporate lands.

We believe that some changes in the gum naval stores industry are inevitable:

1. Economics, more favorable first to the operator then to the landowner and processor, are essential. With the supply and demand situation as it is, it seems to us that the most logical answer to this difficult problem is the lowering of the cost of producing a barrel of raw gum. This is certainly a problem that challenges the best minds of research and industry. All must bend to this task. Just as important an avenue is the better complete use of methods, materials, tools, and information now available. Competent woods supervision and more productive work on the part of laborers would lower production costs for 80 to 90 percent of the operations now in existence. One fact we must never forget--and this ties into improved supervision and labor--working naval stores is a hot, dirty, hard job carried on by a vanishing breed of men. As far as I know there is no alternative to walking from tree to tree to do the job. This phase of the operation offers the greatest challenge for improvement to be made. We feel that economic, marketing, and production research as well as basic tree physiological research, as is now planned, is essential to the future existence of the gum naval stores industry.

2. Woods conditions are rapidly changing. As we plant large acreages of trees in rows, advantages and disadvantages will arise. We will have more faces per acre but these will be narrower in width, with gum generated by smaller crowns due mainly to the relatively short rotation periods so prevalent among the larger landholding companies of today. This might dictate a different contractual arrangement between the landowner and the naval stores producer than is now known. Possibly rental of naval stores rights on a per acre basis rather than on a per face basis might be the method eventually evolved.

3. Trees of superior gum producing characteristics will ultimately be grown and worked. The favorable impact of this worthwhile effort will not soon be realized. We need a shot in the arm now.

Recently, I looked at some of our old records and noticed that in 1940 we received $5,108.98 from naval stores operations on Company lands. It is interesting to note that this money was almost equally divided between our Varn Tract in Beaufort County, S.C., and our Gamble Tract in Clay and Putnam Counties, Fla. We received no naval stores income from our Georgia lands that year, although we are certain operations were carried on by operators who sold their lands to us but retained naval stores rights for designated periods of time. Incidentally, 24 years later we still have a naval stores operation on the Gamble Tract in Florida with 16 crops being worked there at this time.

We have been in the gum naval stores business a long time and we are, we hope, in the business to stay. From our early beginnings, we have always tried to keep pace with the industry's progress. We are willing to try new methods on our properties. We believe we were among the first to have acid used as a stimulant on our lands on a production basis. R. L. Bernard, who is still active in the business, and the late Clarence Newton were the pioneers. At present, we have a pilot operation using 2, 4-D as a stimulant. We have several operations utilizing the concept of front facing for a 2-year period and then back facing for an additional 2-year period. We are even experimenting with an incentive method of payment wherein the more gum produced the less percentage the operator pays. We think this method has some merit.

In closing, most of us have at one time or another thought how wonderful it would be if oil were discovered in Georgia, particularly if it were on our land. Texas produces oil by the thousands of barrels. Southeast Georgia produces gum by the thousands of barrels. And, we have an idea, though not completely substantiated, that the production of a barrel of gum in Georgia means far more to our people locally than a barrel of oil in Texas or any other State. In addition, it is conceivable that long after Texas has been pumped dry of oil, Georgians and Floridians, in their own quiet, deliberate way, will be making money by producing millions of barrels of gum -- by the cupful.

# PROGRESS IN THE SELECTION AND BREEDING OF SUPERIOR TREES TO UPGRADE GUM YIELD

by
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(Presented by R. E. Goddard)

Tree improvement research is now widespread throughout the South. Nearly all public forestry agencies in the region, both Federal and State, and many private companies are currently engaged in tree selection and breeding activities. However, most of these tree improvement projects have given little or no consideration to gum yield and have concentrated instead on improvement of growth rate, timber quality, and wood characteristics. In only one location has breeding work been focused on gum yield improvement--the U. S. Forest Service's Lake City Forest Research Center, now known as the Naval Stores and Timber Production Laboratory.

The work at Lake City, started in 1941, was among the earliest tree breeding efforts in the South. Several researchers have contributed to the project and the work has continued to the present. Early objectives, as outlined by Downs (3), were to select breeding stock, vegetatively propagate them by rooting cuttings, and breed for better trees. In the initial phase, a search was made in natural stands for high yielding trees. Active turpentining crops were checked and 12 trees were selected which had 2 to 2. 5 times the gum yield of comparison trees of the same size and age (2). With some difficulty, techniques for rooting pine cuttings were developed and a small clonal planting of the selections was established on the experimental forest at Olustee. Controlled pollinations were made between high yielders and also with average trees to test the inheritance of this characteristic.

Parallel work concerning the nature of gum yield was conducted. In 1953, Schopmeyer (6) reported that factors controlling or affecting gum flow were: "(1) The size of the radial resin ducts exposed by chipping; (2) the number of resin ducts per square inch of fresh streak; (3) how viscous or fluid the gum may be; (4) and possibly, the pressure within a tree which tends to force the gum outward."

In 1946, about 600 seedlings were planted at Olustee from controlled and wind pollinations of the high yielding selections and average trees. This same year a microchipping process had been developed by Ostrom and True (5) so that yields of small trees could be evaluated. The plantation was microchipped in 1954. From this study it was found that the number and size of ducts were affected by tree age and were apparently not strongly inherited (4). On the other hand, viscosity and exudation pressure were found to be under strong genetic control (1, 4). Squillace and Bengston (7), using data from the seedling and clonal plantations calculated the heritability of gum yield as varying from 45 to 90 percent, depending upon source of data. Their calculations also indicated that gains of 55 percent in gum yield should be possible by phenotypic selection in natural stands and gains of 70 percent by phenotypic selection under more uniform plantation conditions, in both cases using as parents only those trees with 100 percent better than average yield. Progeny testing would, of course, make it possible to increase the gains even more.

Current work at the Naval Stores and Timber Production Laboratory includes selection of additional high yielding trees, particularly those that also have other desirable characteristics. Of the original high yielding selections, only six were adequately tested. Three of these proved to be highly superior and three only moderately so. Over 100 new selections have been made. These trees have very high yield or a combination of high yield and modest superiority in growth rate and timber quality. Many of these are under various stages of testing. In addition, an active controlled breeding program is under way to obtain further gains in gum-yielding ability by selection in second and subsequent generation progenies of proven high yielders.

Since 1954, the University of Florida School of Forestry has been engaged in a tree improvement program with the pulp and paper industry of the region. Several hundred slash pines with outstanding vigor and quality have been selected. Cooperating companies established clonal seed orchards from these selections and a breeding orchard consisting of only one or two grafts from each selection was established at Gainesville.

In 1961, we decided to check the gum yielding ability of these trees, by use of the microchipping technique described by Ostrom and True (5). A total of 531 grafts were large enough for chipping, that is, 3 inches or more in diameter. These represented 373 different slash pine selections--2 grafts each of 158 selections and 1 graft of each of 215 selections.

Microchipping was started in July 1961. With this method, a small gutter and metal can were installed and a 1-square-inch patch of bark and cambium was removed at 2-week intervals. At each chipping the fresh face was sprayed with 50 percent sulfuric acid. Six chippings were made and gum was collected for 12 weeks. At the end of the period, scrape was removed, weighed, and added to the weight of gum collected.

The gross yields from the various individual grafts varied from 20 to 445 grams, with average yield totaling 138.1 grams. By utilizing data only from those clones with two grafted representatives in the orchard, it was possible for me to obtain a statistical test of the variance in yield. Highly significant differences in yield among the clones were found.

It is well known, however, that there is a positive relationship between gum yield and tree diameter. As trees in this test ranged from 2.8 to 5.9 inches in diameter at point of chipping, this 3-inch diameter range in trees of this size could be substantial in effect. Therefore, diameter differences were adjusted by covariance analysis. Diameter differences accounted for only 15 percent of the variation in gum yield.

The portion of the variation attributed to genetic differences between the trees was calculated by using adjusted yields. These computations indicated that 67 percent of the variation in gum yield was due to heredity. Thus, results of this study are in close agreement with findings of Squillace and Bengston's (7) that rapid, substantial gains in gum yield can be realized through selection. Further gum yields of the slash pine population tested, although otherwise normal in distribution, appeared to have a long tail on the high yield side. In this study, individuals with yields nearly 5 standard deviations above the mean showed up. Of the 373 slash pine selections tested 4.3 percent had yields over 2 standard deviations above the mean. Their yields were 1.82 times or more above the average of the population tested. The high heritability indicated suggests that a substantial portion of this superiority could be passed on to their offspring.

However, some trees that yield well in a clonal test do not combine well when crossed with others. For this reason, the best determination of the breeding value of a tree is the progeny test. The best high-yielding clones from the study at Gainesville have been incorporated into the breeding program at Olustee. Pollen from the University of Florida program was supplied to workers at Olustee for crossing with high-yielding selections there.

However, much remains to be done before these results can be applied by commercial gum producers. There often appears to be some misunderstanding about the role of a research agency in this respect. A research agency, whether it be the U. S. Forest Service, a university, or a private organization, produces facts, techniques, and basic knowledge. Whether or not this information is utilized depends upon the reaction of the public concerned with the information, and the initiative of other groups in making practical application possible. An example is the case under discussion. The work at Olustee and at Gainesville clearly demonstrated that it is possible to substantially improve gum-yielding ability of slash pine by selection and breeding and outlined procedures for doing this. But an experiment station is not an agency for the production of pine seedlings to be distributed to turpentine farmers and others who would like to have improved trees.

In the State agricultural experiment stations, where many improved crop varieties are developed, this gap between the farmer and the researcher is filled by the commercial seed producer. Small quantities of seed of a new variety developed by the breeders are released to seed producers who increase them and produce quantities for sale at the risk that they will be wanted in sufficient quantity for the producer to make a profit. With annual crops this can be done in a short time with attractive profit possibilities.

We do not have a parallel situation in forestry. Instead of the simple job of multiplying seed, the lengthy procedure of grafting or controlled pollination, development of clonal or seedling seed orchards and eventual production of seedlings is required before such improvements can be made available in large quantity to planters. This is not a very attractive commercial proposition.

How then is the average turpentine farmer to benefit from the knowledge that is possible to obtain higher yields by planting improved strains? In Florida, at least, the gap between the scientist and the producer is being bridged.

Traditionally, State forest services have accepted, as one of their functions, the production of seedlings for reforestation. The Florida Forest Service has admirably supplied this service in the past and will continue to do so. Also, in line with advances in technology, they are developing orchards to produce seed of improved genetic quality for Florida planters. A program of selection of trees with superior growth rate and timber quality is well under way, and considerable acreage has been planted to grafts of these selections.

In 1963, the Florida Forest Service agreed to commit a portion of their planned seed orchard area to production of seed with improved gum yield potential. The study at Gainesville had revealed that 16 slash pine selections were outstanding in gum-yielding capability. These trees had been orginally selected for superior growth and form by cooperators in the University of Florida forest genetics project. The private companies who had made the selections granted permission to release cuttings from these trees to the Florida Forest Service for use in developing their orchard for gum yield improvement. In addition, 27 clones at Olustee, some of which are progenies of proven high yielders, were made available to the Florida Forest Service for use in developing their orchard for gum yield improvement. Thus, in 5 to 10 years the Florida Forest Service will have available to planters substantial quantities of seedlings with a probable potential of producing 50 percent or more gum than the average planting stock used today.

This, I believe is an example of multiple cooperation seldom equalled. The Southeastern Forest Experiment Station developed techniques and proof that gum yield of slash pine can be genetically improved. Private industries selected trees of high quality for general forestry purposes. The University of Florida screened these selections and determined their potential for gum production. The Florida Forest Service used these high yielders to develop a source of improved planting stock on sufficient scale for eventual use by landowners interested in increasing profits in commercial gum production.

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# REDUCING THE COST OF PRODUCING CRUDE PINE GUM

by
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I believe those of us interested in the gum naval stores industry will agree that we must reduce the cost of producing crude gum. Why we need to reduce these costs will be covered by Bill Nagle and other speakers--what I would like to talk about this morning is how the U. S. Forest Service's naval stores research program is geared to help cut production costs and how our research is progressing.

First, let me explain that we have two distinct phases to our program--basic research and applied research.

The basic research is aimed at providing knowledge and understanding of the life processes involved in the synthesis and translocation of oleoresin by pine trees. This information is absolutely necessary as a foundation for developing practical and efficient techniques, methods, and equipment for producing pine gum on a commercial scale.

Our applied research utilizes the best basic information available to develop and evaluate gum extraction techniques and methods for commercial application. Naturally this phase of our program must be quite flexible. As new information becomes available we must be ready to utilize it promptly to benefit the gum naval stores industry.

In the next few minutes I will summarize both phases of our research efforts at Olustee.

## Basic Research

The basic research program is of highest priority at our laboratory. We feel the greatest present need is for a good understanding of how, why, when, and where a pine tree synthesizes oleoresin. This includes discovering the biosynthetic pathways, the sites of production, the modes of translocation, and the biochemical and physiological processes involved. We also must have an understanding of how environmental influences affect oleoresin production, if we are to obtain maximum yields without seriously impairing the vigor of the tree or the utility of this tree for other wood products.

This research will take time and money and much investigative talent. Fortunately we do not have to tackle the job alone. Other U. S. Forest Service research laboratories are working on related aspects of this problem area, for example, how oleoresin constituents might be related to a tree's resistance to certain insects. The ARS Naval Stores laboratory continues to provide us with valuable information and assistance. Also some universities are conducting or are planning to conduct basic research programs within this broad field.

At our laboratory, the first problem will be to attempt to determine the biosynthetic pathways and sites of oleoresin production with the aid of radioisotopes. Thanks to the cooperation of B. G. Dunavant and the Nuclear Sciences Department of the University of Florida, who are assisting us with this research, equipment and facilities will be ready to launch this program within the next month. The results of this research may suggest entirely new methods of extracting gum from the tree.

This knowledge, together with a better understanding of how traumatic tissue reacts, will also allow us to develop criteria for selecting from the thousands of recently discovered chemicals, promising formulations to test in our search for improved gum flow stimulants. Once we have such criteria for screening new chemicals we should be able to save considerable research time and effort by shortcutting our present trial and error methods of testing chemicals.

Other foreseen uses of basic physiological information include perfecting a simple technique that, combined with diameter and live-crown ratio, will allow us to select high gum-yielding trees and cull out poor yielders before commercial operations begin in a naval stores stand.

To return to subjects more directly related to cost reductions--we all recognize that one method of reducing production costs is to produce more pine gum per tree per year. In this connection some of our basic research has given results that are directly usable in the field. Ray Goddard has told you of the progress in breeding trees for high gum-yielding ability. This year the progeny plantation at Olustee was large enough so that we were able to begin working the trees with full size faces and the standard biweekly bark chipping with 50-percent sulfuric acid.

These trees are the progeny, or offsprings, of the high-yielding parent trees selected and bred during the 1940's. Even though weather conditions have made this a below average year for gum production, some of these trees--only 9 to 11 inches d. b. h. --are going to yield 25 to 30 pounds of gum this year.

Can you imagine how such increased production could eventually affect the gum naval stores industry? Last year production per face, across the entire naval stores belt, averaged about 9 pounds of gum. For the same amount of labor and business investment, but working the Olustee strain of high gum-yielding trees, the yield per tree could have been about 22 pounds. Instead of 200 barrels per crop, by conservative estimate, we could expect 500 barrels per crop. With a 100-percent increase in production per face, the profit margin should also be substantially improved.

In high gum-yielding plantations the net value of the gum from even moderately long naval stores cycles will far exceed the value of the wood produced. Plantations or orchards grown with the primary objective of gum production will be completely feasible as one of the sources for this raw material. Seedlings of the Olustee strain will soon be available to gum producers from the Georgia Forestry Commission. In a few more years the Florida and Louisiana State organizations will also have these seedlings from their recently established seed orchards.

Because of the large variation in gum-yielding ability among individual trees and the strong heritability of gum yield, the best opportunities for increasing the amount of gum obtained from each tree are through utilizing the superior-yielding strains developed by tree breeders. Nevertheless, additional possibilities for increasing the gum-producing capacity of naval stores stands lie in the mainuplation of environmental factors. We are concentrating a portion of our research efforts on learning to what extent we can influence the quantity and quality of gum yields and wood growth through cultural treatments.

In one experiment we are studying how various combinations of irrigation, cultivation, fertilization, and cover crops will affect the amount and quality of gum produced by both high-yielding and average-yielding slash pines. The study is now 7 years old and next season the trees will be large enough to permit collecting preliminary gum-yield data from microchipping. These data may indicate which cultural measures, or combination of measures, will further enhance the yielding ability of both our high-yielding strain and average slash pine trees.

In another study we are concerned with the effects on gum production and tree growth of fertilizers applied to stands of turpentining age. Conversely, this study also is concerned with the effects of turpentining on the nutrition and vigor of the trees. The trees are being worked with intensive extraction methods over a 4-year naval stores cycle, 2 years on the front face, then 2 years on the back. The second year of front face work will be completed this season and interim results from this study should be available.

Through foilage and soils analysis coupled with measurements of tree growth, gum yield and quality, and wood yield and quality, we hope to learn what set of environmental conditions are necessary and feasible for the most profitable production of gum and wood.

## Applied Research

The second phase of our research program--applied research--actually involves some fairly fundamental approaches. Essentially, we are attempting to utilize available basic knowledge to develop, test, and evaluate improved extraction techniques. Our work in this field is centered around learning how to prolong gum flow and improve gum quality. The most promising leads are through the use of new or improved noncorrosive chemical formulations. Of course, an important requirement of any new extraction method is that is must have no serious effect upon the vigor of the faced trees or the value of these trees for other timber products.

We now have one new extraction method that is ready for commercial use.

This new method utilizes 2, 4-D in place of sulfuric acid on drifts of 100-percent slash pine. Even at low concentrations this herbicide will kill longleaf pine so we caution you to use it only in slash pine plantations. Our recommended formulation--a 2-percent (by weight) water solution of the amine salt of 2, 4-D--stimulates gum flow in a manner similar to sulfuric acid. However, the herbicide is completely safe to use--does not harm skin or clothing--and it will not corrode cups or gutters. In recently completed 4-year tests on commercial operations higher grades of gum were produced on the 2, 4-D drifts the third and fourth year of work than on the acid drifts. During the fourth year of work the 2, 4-D areas produced WW and WG gum--the acid areas produced Kate. On the acid areas virtually all of the zinc coating had been corroded away from the galvanized iron hardware by the sulfuric acid.

Use of 2, 4-D in slash pine drifts should increase profits through 1) production of high-grade gum--worth roughly $2 more per barrel to the producer, 2) longer life to cups, and 3) a better grade of woods work because of the improved working conditions.

Detailed instructions for using 2, 4-D will be published this fall.

Another new extraction method that we are investigating involves the use of paste formulations. In recent years Polish researchers have been experimenting with applying sulfuric acid to naval stores faces in a paste form. The technique looked promising to us and 3 years ago we began developing exploratory sulfuric acid paste formulations. Theoretically, the paste should allow slow and constant diffusion of the acid or, for that matter, other chemical stimulants. This, in turn, could result in a more constant flow of gum over a longer period of time than we presently obtain with water solutions of acid.

Newport Industries, Division of Heyden Newport Chemical Corporation has cooperated closely with our laboratory in all phases of our paste research. We now have several acid paste formulations with which to work. All are about the consistency of tooth paste with excellent adhesive and retentive qualities. They can be readily applied with a hand-squeeze type plastic applicator.

These pastes have been tested in several acid concentrations, ranging from 10 percent through 65 percent, and with biweekly, triweekly, and monthly chipping intervals.

With biweekly chipping intervals, yields per inch of face height from the lower concentrations of acid paste compare favorably with our standard aqueous solutions of sulfuric acid. The higher concentrations of acid paste on a biweekly schedule produced exceptionally high gum yields, but a disproportionate amount of face height was used up. Also, on trees of low vigor, second-year yields were often quite low following a very productive virgin season.

In other tests, triweekly chipping with 40- to 65-percent acid paste, has given yields equaling or exceeding the yields from biweekly bark chipping with the standard aqueous acid solution. More simply stated, yields from 11 streaks treated with paste were equal to yields from 16 streaks treated with the standard aqueous solution.

With monthly chipping intervals, the higher concentrations of acid paste have produced yields from 85 to 88 percent of the yields from biweekly chipping with the standard aqueous solution. As a minimum goal, through continued research we are striving to raise these yields from monthly chipping to a consistent 90 to 95 percent of the yields from standard biweekly work.

In general, our acid pastes have not given yields commensurate with the amount of face height used. This coming season our research will focus on more detailed investigation of the effects of acid paste on the cellular structure of the tree in the immediate vicinity of the wound. Through gaining more knowledge about the action of acid paste we hope to harness the tremendous plasmolytic ability of this formulation and prolong the flow of gum without unnecessary sacrifice of face area.

Besides its superiority in prolonging gum flow, acid paste sticks where it is applied. Consequently, this treatment is safer to use, causes less cup and gutter corrosion, and, because the bead of paste is easily seen, can be more effectively supervised.

While acid paste is not sufficiently perfected for general use on commercial operations, we feel the time is ripe for pilot-plant testing of this technique. This coming season tests will be installed on commercial operations in the vicinity of Olustee. These field trials, with close supervision by research personnel, will expose operational problems associated with using paste and allow us to tailor this gum extraction method for efficient use by the gum naval stores industry.

A commercially feasible extraction method, based on monthly chipping and paste treatment would mean significant reductions in production costs and labor requirements. Also this extraction method could reopen the possibilities of disposable cups and gutters, since the higher costs of these containers would be offset by general reductions in operational expenses. Using disposable containers and replacing them adjacent to the fresh streak each time the face is chipped, would produce higher grade gum through elimination of iron contamination, trash accumulation, and scrape. Of course, with acid paste care would be needed to keep from destroying these containers. With noncorrosive stimulators even this would not be a problem.

At the present time, each worked face is visited from 25 to 30 times a year--for tin tacking, streaking, dipping, and scraping. With monthly chipping and dipping in one operation and no tin tacking or scraping needed, a minimum of eight visits per face per year would be possible. Probably the same size crew now needed to handle the various operations on one crop would eventually handle three crops or more.

Working 25 faces per acre and visiting each face just 26 times per year, laborers now walk 2, 080 miles per year while working a crop of faces. With only 8 visits per year on the same 25 faces per acre, this mileage would be reduced 640 per year per crop.

While we're crystal-ball gazing, let us go back to our plantations of Olustee high-gum-yielding trees. Let us assume we had planted these superior trees at 15 by 15 spacing on slightly better than average sites. Our plantation growth and yield data indicate we'll have 150 trees per acre at age 20 with an average diameter of 10 inches and 50 percent live crown. This is six times as many faces per acre as we are currently working, but for the best use of these superior trees a maximum number per acre should be worked.

Now with 150 faces per acre, instead of our present 25, and with 8 visits to each tree per year instead of 26, a crop of Olustee high gum-yielders would produce over 500 barrels of premium grade gum and require only 256 miles of walking per year. Compare this with our present yields of 200 barrels per crop and 2, 080 miles of walking. And this comparison does not include possible additional yield increases due to utilizing the optimum combination of environmental factors.

In addition to our work with paste and 2, 4-D we will also be screening promising chemicals in our continuing search for improved noncorrosive gum flow stimulators. Based on our present knowledge, stimulators will probably not be found which significantly increase gum production without seriously affecting the vigor or growth rate of the worked trees. However, some of these new chemicals may be excellent for prolonging gum flow, and suitable for use in water, pastes, or some new type of formulation.

As research progresses with new extraction methods and new formulations, a certain amount of equipment development must be carried on to allow adequate appraisal of these materials or techniques. This development of "hand" equipment is conducted at Olustee in conjunction with our regular program. However, in 1961 when the U.S. Forest Service established its Forest Engineering Research Laboratory at Auburn, Ala., the major equipment development research for all types of timber operations in the South was assigned there. This new engineering laboratory, under the direction of Heyward Taylor, is now responsible for preparing design criteria that can be used to develop systems for mechanizing the woods end of the gum naval stores industry. Recently this laboratory, with the cooperation of agricultural engineer Charles M. Stokes, of the Auburn University Agricultural Experiment Station, began a preliminary study of the areas of research needed for development of more efficient systems for commercial gum operations. Our staff at Olustee will be working closely with this new laboratory and I know that you all will be interested in assisting these research engineers.

In closing, let me emphasize the importance of pilot-plant testing to our overall program. Our researchers can discover new knowledge and information, but this information must be utilized in new techniques, methods, and equipment if the gum naval stores industry is to benefit. Some very progressive producers develop their own ways of doing things, but for the bulk of the producers research data must be presented in a usable form. In our pilot-plant tests, under the supervision of Ralph W. Clements, promising innovations are given field trials on commercial operations. Through the help and understanding of cooperating producers, we are able to work out the operational problems associated with any new development and tailor this development so that it can be used by all producers and is acceptable to the timber owners.

However, these pilot-plant operations are more than just proving grounds. Through testing research developments under field conditions, and through discussions with gum producers, laborers, foresters, and timber owners, new ideas are stimulated. When these ideas are fed into the proper area in our research program, they often open up whole new fields of consideration. So actually, while certain projects can be wrapped up in neat bundles, field tested, and marked "ready for use," we in research look at the completion of one research project as an opportunity to concentrate more effort on other projects or to begin new research that may turn out to be even more profitable to the gum naval stores industry.

# CURRENT PROBLEMS AND OPPORTUNITIES IN THE PRODUCTION OF PINE GUM

by

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It is indeed a pleasure for me to be here with you today to discuss some of my viewpoints on the current problems and opportunities in the production of pine gum.

When my company started producing oleoresin back in 1931, even a cursory survey of the price history of rosin and the naval stores industry indicated that the production and sale of rosin was still a relic of colonial days, that the product would continue to fluctuate widely in price, and the methods of producing were still relatively primitive. With the exception of a few innovations such as bark chipping, acid stimulation, new tin tacking methods, and slightly better transportation, the production of pine gum is still relatively primitive.

Daniel Webster defines a problem as a question proposed for solution; hence, a perplexing question, situtation, or person. There are, indeed, perplexing problems which I shall discuss briefly, and I will sum them up as follows, not necessarily in order of their importance:

Poor producer management.

Lack of trained labor.

Lack of good supervision.

Lack of confidence and a relatively poor relationship between producer and processor.

Lack of sufficient research to make economic gum production.

Loss in export market--rosin stocks continue to mount in the face of sagging demand.

Decline in rosin utilization such as paper coatings, soap, and paper sizing.

High costs of leases.

Too thickly grown timber, thus, shortening crown ratios which causes poorer gum yields.

Lack of a good system for grading gum that would be acceptable both to the producer and processor.

Large investment necessary before an income can be realized.

Poor hardware.

Poor hardware removal.

Corrosive chemical stimulants.

Too many grades of gum.

Lack of sufficient manpower.

Insect problems.

Declining production on extremely hot days.

I would like to take just a minute or two to elaborate on some of these problems.

Poor producer management. Most producers continue the old-fashioned system of paying laborers' bills. They sell the laborers groceries on credit, make his car payments, gasoline, bottled gas, electricity, doctors' bills, drugs, dentists, little packages in the post office, and just plain "I need $10" loans. Under most conditions, the laborer builds up a large account for he charges more than he makes, and before he knows it, he is deeply in debt to the producer. Most producers seem to go along with this under the theory that they have a hold on the laborer because he owes the boss so much. This is negative thinking and must be changed before our industry will be able to advance. It has been our experience that the only difference between a laborer who owes a lot and one who doesn't is that when they have had enough, the one who owes money will run out, and the one who doesn't will walk out. Until all naval stores operators stop this practice, we will continue to have a poor grade of labor, for we have made them this way.

High costs of leases. Naval stores operators cannot pay 25 and 30 percent leases for naval stores timber unless the timber is of an unusually large size diameter-wise or some concession is made such as the landowner furnishing cups, tins, housing, or some other gimmick. In my opinion, a 20 percent lease with a 15 cent minimum per face per year guarantee is all the tariff allows. The above type lease makes the lessor and lessee a bit happier. Conceivably, more money is made by the timber owner due to the fact that the lessee will work lower priced leased timber if he is short of labor and let the higher priced leased timber go.

Large investment necessary before an income can be realized. I cannot think of a business that one starts without making some kind of investment, and this covers the naval stores industry. In order to hang or install a crop of boxes (10, 000 faces), the average investment necessarily runs between $5, 000 and $7, 000, which is exceedlingly high in view of the price obtained for the end product.

All of this appears to paint a mighty gloomy picture on entering the production of gum naval stores field. It is my qualified opinion, that if our company were not set up to produce gum, we would not do so.

On the brighter side of the picture, there are opportunities which we must consider and one of the most important I can think of is that a higher income can be realized by a landowner who has timber to lease for naval stores purposes. By so doing, this landowner can realize more revenue per acre before liquidation of his tree crop.

Other opportunities include: Research on new stimulants which will increase the production of gum and, thus, help solve labor shortage problems.

A farmer can realize a supplemental income by working his own timber, and this is good.

Good supervisors can be encouraged by paying higher salaries.

The American Turpentine Farmers Association (ATFA) Program offers a real opportunity if all people involved cooperate.

If, as stated, wood rosin production declines, gum rosin stands a chance to improve its position.

The turpentine situation is improving. After the government subsidy was removed at the end of 1960, prices went as low as 15 cents per gallon; but, in recent months they are almost back to original subsidy prices of 50 cents per gallon.

Naval stores give jobs to unskilled labor. The government seems to believe there aren't jobs for unskilled labor, but this isn't necessarily so in seven southern States. There is plenty of opportunity in the gum naval stores field. Good unskilled labor can make from $50 to $65 per week, with free housing, water, etc. A lot of our labor works only 3 to 3-1/2 days per week, or 24 to 30 hours. The government and some industry have been talking about a 35-hour week. They're behind times, for our labor invented it and went them one better.

Finally, gum naval stores are in a position to expand around sevenfold in the case of growing demands for the derivatives of oleoresin.

Session II - Marketing

J. H. Stump, Jr., Chairman

# PROPERTY TAXES ON RURAL LAND IN GEORGIA

by

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The current situation. --A detailed study of property taxes on forest and nonforest land in Georgia was initiated in 1963. The objectives of the study were to determine the current situation relating to ad valorem taxes on rural land in the State and to arrive at recommended guidelines for improvement of the methods and systems currently used. The work was a cooperative effort of the University of Georgia,[1] the Georgia Forest Research Council, the Georgia Forestry Commission, and the Georgia Forestry Association.

Information pertaining to the current situation was obtained through personal interviews with local authorities in each county. Fulton and Dekalb Counties, encompassing metropolitan Atlanta, were excluded from the study because of the scarcity of rural lands within their boundaries.

Standing timber is classed as realty in Georgia; therefore, it must be legally considered as part of the land until severed from the stump (4, 5). By contrast, agricultural products are specifically exempted from ad valorem taxation by law. Georgia Code Section 5-606 states that, "all agricultural products in Georgia shall be exempted from taxes and license, except as herein stated" (Acts of 1945, p. 265). This provision prohibits the taxation of agricultural crops as property, either as personalty or realty. The growing, cultivation, and harvesting of trees and the fruits and products thereof are treated as agricultural pursuits, but the trees themselves are excluded (1).

The foregoing statutory distinctions between forest and agricultural land for taxation purposes would appear to require that all counties (1) base all property assessments on fair market values and (2) make a clear distinction between timberland and land used for growing agricultural crops. Information gathered in 1963 through personal interviews with tax officials in 157 counties however revealed that:

1. Fair market values were used as a basis for assessing lands in only 65 counties.
2. Only 82 counties reportedly made a distinction between forest and nonforest lands for the purposes of assessment.
3. Twenty-six counties "considered" timber during assessment (for example, poor, average, good) but did not assign separate values to land and timber.
4. Only eight counties reportedly assessed timber and land separately.

Thus, it would appear that in a majority of Georgia Counties the assessment of timberland (and perhaps all rural land) up to now has been approached in a more or less arbitrary manner. It is likely that assessing practices have not disturbed landowners in earlier years primarily because taxes have been generally held to low levels. County tax revaluation programs have changed all this, for such programs have generally resulted in higher assessed values, lower millage rates, and increased property taxes which, if continued, could well become confiscatory for forest lands.

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[1] Project S-290 College Experiment Station.

Table 1 presents a Statewide summary of the forest and nonforest tax situation for 1953 and 1963. Median values are shown, because arithmetic means were biased by counties having large urban centers. It is noteworthy that the ranges in taxes per acre do not differ greatly for forest versus nonforest lands. The fact that forest land taxes are often equal to (in some cases greater than) those applied to nonforest lands is causing increasing concern among timberland owners. There is a growing feeling, and with considerable justification, that timberlands are frequently not receiving fair and proper treatment for tax purposes.

Table 2 compares 34 counties which have had revaluation programs with 123 counties which have not as yet been revaluated. Millage rates have dropped, but not enough to offset considerably higher assessed values in the revalued counties. The result is a higher upper limit of taxes per acre, although the lower end of the range remains approximately the same as before revaluation. A most disturbing trend seems apparent from this tabulation. Millage rates will gradually increase from the reduced level and assessed values will not decrease, thus resulting in increased tax per acre in the future.

Table 1.--Assessed values, millage rates, and tax per acre for 157 Georgia counties[1]

| Year and kind of land | Median assessed value | Median millage | Median tax per acre |
|---|---|---|---|
| | Dollars | | Dollars |
| Forest land: | | | |
| 1953 | 4.00 to 6.00 | 41.25 | 0.17 to 0.22 |
| 1963 | 6.00 to 10.00 | 45.00 | .26 to .45 |
| Nonforest land: | | | |
| 1953 | 5.00 to 8.00 | 41.25 | 0.20 to 0.32 |
| 1963 | 7.25 to 12.00 | 45.00 | .32 to .60 |

[1] Excluding DeKalb and Fulton Counties.

Table 2.--Assessed values, millage rates, and tax per acre by revalued and nonrevalued county grouping, 1963[1]

| Assessment group | Median assessed value | Median millage | Median tax per acre |
|---|---|---|---|
| | Dollars | | Dollars |
| Forest land: | | | |
| 34 Revalued counties | 8.00 to 29.00 | 28.00 | 0.22 to 0.71 |
| 123 nonrevalued counties | 6.00 to 8.00 | 48.00 | .26 to .42 |
| Nonforest land: | | | |
| 34 Revalued counties | 10.00 to 39.00 | 28.00 | 0.32 to 1.00 |
| 123 Nonrevalued counties | 7.00 to 10.00 | 48.00 | .32 to 0.51 |

[1] Excluding DeKalb and Fulton Counties.

Unfortunately, there was no efficient method for determining just how much forest land is taxed at the lower end of the ranges shown and how much falls near the upper limits. County tax digests do not list proportions nor acreages of forest versus other types of rural land.

A stratification of 157 counties by 7 tax per acre groups is presented in table 3.

Table 3. -- Classification of 157 Georgia counties by median tax per acre groups[1]

| Tax per acre[2] (dollars) | Forest land |  | Nonforest land |  |
|---|---|---|---|---|
|  | 1953 | 1963 | 1953 | 1963 |
| 0. 10 or less | 17 | 0 | 9 | 0 |
| . 11 to 0. 20 | 61 | 17 | 43 | 12 |
| . 21 to . 30 | 47 | 29 | 42 | 19 |
| . 31 to . 40 | 14 | 43 | 30 | 29 |
| . 41 to . 50 | 10 | 28 | 15 | 24 |
| . 51 to 1. 00 | 6 | 24 | 12 | 51 |
| 1. 01 and more | 2 | 16 | 6 | 22 |
| Total number of counties | 157 | 157 | 157 | 157 |

[1] Excluding DeKalb and Fulton Counties.

[2] Tax per acre derived from midrange of reported values within each county.

Whereas 17 counties taxed forest land at 10 cents per acre or less in 1953, none were reported this low in 1963. A total of 125 counties taxed forest land at 30 cents per acre or less in 1953; in 1963 this number had dwindled to 46 counties. At the high end of the range only 2 counties had forest land taxes greater than $1. 00 per acre in 1953, but by 1963 this number increased to 16 counties.

Taxes on nonforested lands have shown similar increases during the 10-year period, 1953-63. In general, taxes on these lands are higher than on timberlands, but not in a great amount. The fact that forest land is causing many owners to feel that their woodlands are not being fairly or properly taxed. The pattern of increasing land taxes is occurring all over the State, and the increases often appear independent of population trends and changes, or type of land use.

The need for improvement in the taxation of forest land in Georgia has long been recognized by tax assessors as well as forest landowners. Variation in procedures and assessment levels as revealed in this study confirms and intensifies this need.

The most critical area of ad valorem taxation is the assessment procedure, and correction appears to be a most difficult task because of the nature of the property being assessed. The result is that land is arbitrarily assessed, èither at a flat rate, seemingly without regard to value, or within an arbitrary range of assessed values designed to produce the required revenue. Neither of these methods carry out the letter or the intent of the Georgia laws regarding ad valorem taxation.

Justification of proposal. --Georgia's basic land tax is the ad valorem tax. There is at present no yield, severance, or modified forest land tax. Investigations of the history of these types of taxes in other States lead the authors to believe that they offer no basis for improving the forest land tax situation in Georgia. The yield tax presents serious problems because of fluctuations in income from year to year, which would not be acceptable to many local governments. The severance tax has no relationship to the property tax. It is a tax levied in addition to the property tax. Modified taxes on forest lands create many problems and complexities which seem undesirable.

Currently the Georgia Code specifies that "All property shall be returned for taxation at its fair market value." (2) An assessment ratio is usually applied to the fair market value to arrive at the assessed or taxable value. Georgia courts have consistently held that standing timber is realty (5).

As soon as timber is severed from the stump it becomes personalty (4). Under these holdings the trees must be considered as part of the land and, as such, considered in setting the assessed value of the land. However, agricultural products are expressly exempt from ad valorem taxation by statutory provisions (3).

The assessment of standing timber in the same manner as the land which supports it is fundamentally wrong. When land and timber are assessed together or when the value of the existing timber stand is added to the value of the land for purposes of determining annual taxation, the annual growth of each year in the life of the stand is taxed during every subsequent year until harvest.

In other words, the growth which occurs the year a stand is established is taxed not only during that year, but in all other years of the rotation. With a 30-year rotation, the first year's growth is taxed 29 times, the second year's growth is taxed 28 times, and so on. The difference between an annual crop, like cotton, and a crop harvested only once in a period of years, like timber, is obvious. No tax collector would attempt to secure tax payments on a given cotton crop for more than the single year in which the crop was grown. The fact that the annual growth of a timber stand is not harvested each year should not make that growth subject to taxation for more than the 1 year in which it occurred.

The tax on a merchantable stand of timber, just before cutting, will have been collected during each year of the life of the stand if annual growth (productivity) is the basis for evaluation. There should be no tax liability against the accumulated growth at the time of harvest. This protection for the timber grower encourages him to practice good forest management by realizing the maximum yield from the site and by carrying the timber crop through to economic maturity.

On the contrary, assessing (and taxing) timber land or land plus timber bases on a current market value, year after year, can lead only to premature cutting and liquidation of the timber-growing enterprise. This taxing procedure is entirely inconsistent with the principles of sound forest management. Those who manage their lands, and thus have better stands of timber, are taxed at a higher rate than those who do not manage or who mismanage their stands and have poor quality and a small quantity of timber. A stagnated stand of timber with little or no growth may be taxed at a high rate because the timber standing is old growth timber, whereas a good highly productive site may be taxed at a low rate because of poor stands resulting from uncontrolled fire, poor cutting practices, or other acts of poor management.

The current classification of timber as realty creates problems in assessment that are difficult to resolve if the law is strictly followed. The very nature of a constantly changing biological entity such as a stand of timber means that each year there is a change in value created by growth, mortality, or harvesting operations. Thus the requirement that the timber be assessed places heavy burdens on this system to meet the ideals of effective administration and cost of assessment compared to revenue received. In addition, the assessment of standing timber in the same manner as the land which supports it, is fundamentally wrong.

The answer to this is to have valuation based on productivity. This is not a new concept except as applied to woodlands. Agricultural land is classed as excellent, good, fair, poor, and so forth, and this classification is based on nothing more than the productive capacity of the land. An acre of good cotton land is one that will produce 1-1/2 or more bales of cotton per year. A poor acre will produce less and is taxed accordingly. Urban property has long been taxed relative to its ability to earn income. Location and improvements are factors affecting urban real estate valuations and these are direct measurements of income producing capacity. It is not unreasonable or illogical that timberlands should be valued and taxed on the same basis--their productive capacity.

The use of productive capacity as the basis for assessment of forest land would encourage good management. The person with the best class land would have to pay the top tax rate and would thus be encouraged to manage his land in order to get the greatest income from it, if for no other reason than to pay the taxes.

An assessment on productive capacity would greatly simplify and increase effectiveness of administration of the property tax. All forest land in the State would be classified into one of a number of productive capability classes based on factors such as site index and quality. Once the classification is made, frequent revisions would not be necessary because the productive capacity changes very little in the absence of drastic external factors such as severe erosion, water inundation, or mechanical changes.

There are a number of ways to measure the productive capacity of forest land. The most accurate method is actual measurement of the growth of a stand of trees under ideal conditions--good stocking and stand composition--but this also is the most time consuming and difficult method.

One of the most reliable and widely used means of measuring productive capacity of forest land is by the use of site index. Site index is defined as an expression of forest site quality based on the height of the dominant stand at an arbitrarily chosen age. The age of 50 years is commonly used in the South. From established curves, site index may be estimated for a stand of trees of any age.

The reason site index is so widely accepted as a measurement of productive capacity is that the height of a tree is, except in very rare circumstances, determined primarily by the characteristics of the site. It is not affected by environmental factors other than site quality, whereas diameter is affected by factors such as stand composition, density, silvicultural practices, and so forth.

Extensive research in the field of soil-site index relationships has indicated that there is a close relationship between soil series and site index. Site index varies for a given soil mapping unit by species because some species are better adapted to certain soils than to other soils.

The U.S. Department of Agriculture's Soil Conservation Service has published tables showing the average site index for major soil series and major tree species. These tables are available for use in classifying soils by productive capacity.

Implementation of guidelines--Considerable effort will be required initially to implement this assessment guide on the part of tax assessors and the State Revenue Department. However, the proposed guidelines offer long-range economies in the administration of the property tax on forest land. This system of assessment is based on the productive capacity of the land as related to site index.

The first step in its implementation is the classification of all forest land ownerships by site index. There are two feasible methods of accomplishing this requirement. One method is to make necessary field measurements on each forest property sufficient to determine a reasonably accurate average site index for the property as a whole. The measurements required are relatively simple and instruments required for the job are inexpensive. Ideally the job should be done by professional foresters, but most Soil Conservation Service technicians and County Agents have had sufficient training to do this work. It is possible that assessors may obtain help from Georgia Forestry Commission personnel in performing this work. Assessors themselves could be given special training in the procedures for determining the average site index of a property, but since the job will only have to be performed once in the foreseeable future on most forest land they may prefer to seek assistance from other public agencies and concentrate their efforts on providing up-to-date ownership maps for use in this project.

However the job is accomplished, the objective is to obtain an average site index by ownerships.

Another method of obtaining this average site index is by the use of soil maps. As previously mentioned, the Soil Conservation Service has mapped much of the land in Georgia by soil series. These soil series have been grouped into woodland suitability groups by three major resource areas. These areas are:

(1) The Limestone Valley and Mountain resource area

(2) The Piedmont resource area

(3) The Coastal Plain resource area

This information has been published by the Soil Conservation Service (6).

These woodland suitability groups are correlated by species of trees with site index. With proper ownership maps it would be possible to determine site index on a given property with these soil maps, with very little field checking. If aerial photographs are available, species groupings could be determined and the land classified by site index with reasonable accuracy in the office.

The fact that the site index, which is a measure of productive capacity, seldom changes in the absence of external factors, means that this job would only have to be done one time except in rare instances.

Tables of values by site index classes--Once the land is classified by site index, the assessor needs to know the value of the class. It is impractical to expect each county to calculate the worth of each individual property by using the market, cost, or income approaches ordinarily used in forest valuation.

To further simplify the job on the local level a committee composed of assessors, appraisers, foresters, soil scientists, and so forth, should be appointed by the State Revenue Commissioner for the purpose of annually calculating a range of assessed values to be applied to each site index class for each of the three resource areas in Georgia. These tables should be published by the Revenue Department and recommended to local assessors for their use.

This committee would consider the productive capacity of site index classes and would determine a range of values for each class in each resource area. General market conditions and area locations would be considered in setting these values. However, specific locational factors within the county which would influence the basic land value would be determined by the local tax assessor within the published range of values for a specific site index class, as indicated in table 4.

The approximate average site index for forest land in Georgia is 70 feet. Using the 70-foot class as a base figure, projections of costs and returns and average sales prices indicate that the fair market value of the land should be from $12.00 to $20.00 (7). The 40-percent assessment ratio recommended by the State Revenue Department for revaluation studies would be used in determining the range of assessed values from $5.01 to $8.00. Growth and yield studies furnish a guide for variations from the base figure of 70 feet. On this basis a millage rate of 50 times the assessed values gives a range of $0.25 to $0.40 as the tax to be levied for site index 70 in the Coastal Plains Resource Area. In 1963, the average median range of taxes was $0.26 to $0.45.

Table 4.--Assessed values of forest land by site index classes (Based on 40-percent assessment ratio)

| Site-index class (feet and area) | Range of assessed values |
|---|---|
| | Dollars |
| Coastal Plain Resource Area: | |
| Less than 56 | 0.50 to 2.00 |
| 56 to 65 | 2.01 to 5.00 |
| 66 to 75 | 5.01 to 8.00 |
| 76 to 85 | 8.01 to 12.00 |
| 86 to 95 | 12.01 to 16.00 |
| 96 to 105 | 16.01 to 24.00 |
| 106 to 115 | 24.01 to 32.00 |
| 116 and over | 32.01 to 40.00 |
| Piedmont Resource Area: | |
| Less than 56 | 0.50 to 1.50 |
| 56 to 65 | 1.51 to 4.00 |
| 66 to 75 | 4.01 to 8.00 |
| 76 to 85 | 8.01 to 12.00 |
| 86 to 95 | 12.01 to 16.00 |
| 96 to 105 | 16.01 to 24.00 |
| 106 to 115 | 24.01 to 32.00 |
| 116 and over | 32.01 to 40.00 |
| Limestone Valley and Mountain Resource Area: | |
| Less than 56 | 0.50 to 1.50 |
| 56 to 65 | 1.51 to 4.00 |
| 66 to 75 | 4.01 to 7.00 |
| 76 to 85 | 7.01 to 11.00 |
| 86 to 95 | 11.01 to 15.00 |
| 96 to 105 | 15.01 to 20.00 |
| 106 to 115 | 20.01 to 28.00 |
| 116 and over | 28.01 to 36.00 |

To be objective, the local assessor could determine the base level within the range of assessed values at which the average ownership from the standpoint of location of the property will be placed. If he determines this to be $6.50 (midpoint of range) for site index class 66 to 75, he then must determine if this particular property should be assessed either below or above the base value for the class by the use of locational factors.

In some instances questions will arise on a particular property as to whether it should be properly classed as forest land or for some higher use. These questions of necessity must be left to the local assessor, and to the arbitration procedure when disagreements between the assessor and landowner arise.

This proposed assessment guide fulfills to a degree the requirements of the ideal tax system. It can be administered effectively and at low cost compared to returns expected. It should help to standardize assessments between and within counties. It allows landowners to predict with reasonable accuracy their tax liability. It eliminates the necessity of trying to determine annually the constantly changing amount, quality, and value of the standing timber by the local assessor. Local governments are assured of a stable tax base which is not possible with the yield tax, because of fluctuating volumes of timber cut from year to year. It places the taxation of forest land on the same basis as agricultural land; that is, productive capacity. Further, it is a system which will allow forest owners to manage their lands for the production of goods and services for the public on a businesslike basis. There would be, in effect, a penalty on the owners who do not properly manage their lands in that they would have to pay taxes as great as those who do properly manage the same class of land.

While there are many refinements which could be introduced into this system one of its greatest assets is its simplicity. It represents a reasonable and equitable approach to the assessment of forest land and would do much for the progress of Georgia.

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# DEMAND AND PRICE SITUATION FOR ROSIN AND TURPENTINE

by

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I am grateful for this opportunity to take part in the Naval Stores Work Conference and have been looking forward to participating in it for many weeks. It is always stimulating and a pleasure to renew friendships and exchange views with members of the naval stores trade. This year we confront the twin challenges of continued excess of domestic rosin supplies over requirements and a scarcity of turpentine.

Several years ago the word "GAP" came into increased usage. There was the missile gap, real or imaginary, through which we passed, happily unscathed. Scarcely less memorable to most of us here today was the rosin supply gap. There spring nostalgically to mind, hoards of eager consumers and dealers in search of illusive rosin with money no object. Even as some of us reminisce longingly about the rosin supply gap, the frustrated consumers and dealers of that era would approach nirvana at a glimpse of today's well-stocked rosin yards.

Today, we have two contrasting gaps-- a rosin utilization gap, and a turpentine supply gap.

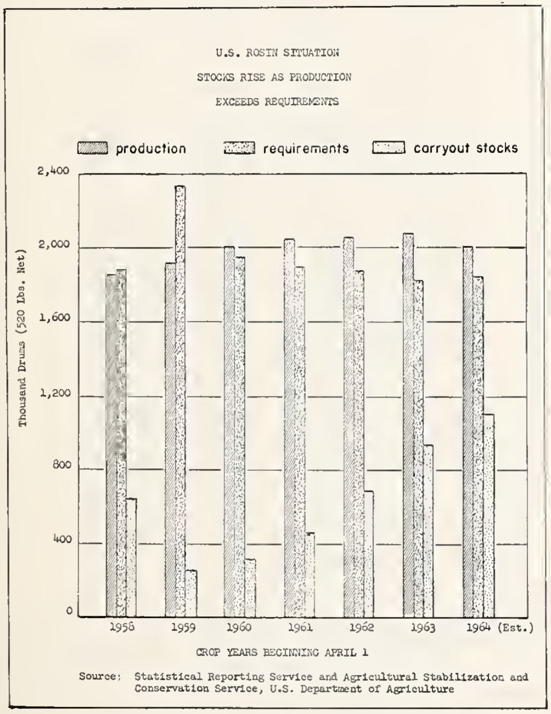
The rosin utilization gap, that is, the disparity between domestic rosin production and requirements, is smaller in 1964 than last year. This results from lower rosin production and gradually increasing disappearance. That the gap is still substantial is evidenced by the continued increase in supply of domestic rosin. Future outlook is for closer overall alignment between rosin production and requirements and between prices of United States and foreign rosins.

The turpentine supply gap is evidenced by shrinking stocks and rising prices.

During the 1964 crop year ending March 31, 1964, the market value of the primary processed derivatives from all types of naval stores is estimated at about $130 million. Notwithstanding the relatively strong market position of turpentine, the market value of domestic rosin output is estimated to be about eight times as great. As turpentine prices rise, however, demand for turpentine is reasserting itself as a determinant in the supply of gum and steam distilled wood naval stores.

Rosin production

Domestic production of all types of rosin will decline in 1964 for the first time in 6 years (see Table 1 and Figure 1). Production is estimated at 2, 010, 000 drums, or about 3-1/2 percent below the 1963 level. Sources of output continue to shift. Gum rosin production is expected to be down about 12 percent and SD (steam distilled) about 7 percent. The aggregate decrease should more than offset an 11 percent rise in tall oil rosin output. During the 1964 crop year, rosin production should divide percentage-wise about 20-51-29 among gum, steam distilled, and tall oil sources. The substantial decline in gum rosin output during 1964 is attributed primarily to reduced yields caused by adverse weather rather than the slight reduction in croppage. Lower steam distilled production reflects reduced importation of pine wood extract and increasingly intermittent operation of some plants in the Western Gulf States. The sharp increase in tall oil rosin production is based on expanding crude tall oil output, an increasing percentage of which is utilized in fractionation or distillation. Thus, during the period April through July 1964, crude tall oil output increased 11 percent over the same period in 1963. Moreover, during the 4-month period in 1964, about 85 percent of crude tall oil was fractionated or distilled, compared with less than 80 percent a year earlier.


U.S. ROSIN SITUATION
STOCKS RISE AS PRODUCTION
EXCEEDS REQUIREMENTS

Source: Statistical Reporting Service and Agricultural Stabilization and Conservation Service, U.S. Department of Agriculture

Figure 1

Unless turpentine prices increase sufficiently to stimulate naval stores output, the outlook for 1965 is for a further decline in overall domestic rosin production.

Turpentine production

Production of all types of turpentine in 1964 is estimated at 665, 000 barrels, 1 percent under the 1963 level, but otherwise the heaviest output since 1951. Sulfate turpentine is expected to compose 59 percent of the total output, S. D. wood turpentine 22 percent, and gum turpentine 19 percent. In 1965, growth in sulfate turpentine (retarded by increased utilization of chips and by pulpwood storage practices) nevertheless is expected to offset decreased output from gum and SD sources.

Rosin requirements

Rosin requirements are expected to be slightly higher in 1964. Production of paper and board and styrene butadiene (SBR) rubber are increasing by about 6 percent in 1964. Together, these two markets account for over half in domestic disappearance of rosin.

## Table 1.--Rosin and Turpentine: Supplies, Requirements, and Prices. Crop Years Beginning April 1, 1958 through 1964.

September 21, 1964

ASCS - Producer Associations Division

| Crop Year Beginning April 1 | Commodity and Type | SUPPLY |  |  |  | REQUIREMENTS |  |  | Carry-out Stocks 1/ | Average Price |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Carry-in Stocks 1/ | Production | Imports | Total Supply | Domestic | Export | Total |  |  |
|  | ROSIN (520 lb. Drums) |  |  |  |  |  |  |  |  | $ Per Cwt. 2/ |
| 1958 | Gum | 559,450 | 369,350 | 600 | 929,400 | 278,430 | 101,630 | 380,060 | 549,340 | 8.33 |
|  | S. D. Wood | 70,740 | 1,182,620 | -0- | 1,253,360 | 845,880 | 342,870 | 1,188,750 | 64,610 | - |
|  | Tall Oil | 38,660 | 305,060 | -0- | 343,720 | 252,220 | 64,450 | 316,670 | 27,050 | - |
|  | Total | 668,850 | 1,857,030 | 600 | 2,526,480 | 1,376,530 | 508,950 | 1,885,480 | 641,000 | - |
| 1959 | Gum | 549,340 | 334,110 | 2,110 | 885,560 | 408,420 | 305,620 | 714,040 | 171,520 | 9.59 |
|  | S. D. Wood | 64,610 | 1,198,690 | -0- | 1,263,300 | 811,840 | 396,550 | 1,208,390 | 54,910 | - |
|  | Tall Oil | 27,050 | 382,970 | -0- | 410,020 | 305,480 | 79,840 | 385,320 | 24,700 | - |
|  | Total | 641,000 | 1,915,770 | 2,110 | 2,558,880 | 1,525,740 | 782,010 | 2,307,750 | 251,130 | - |
| 1960 | Gum | 171,520 | 370,150 | 350 | 542,020 | 262,110 | 156,720 | 418,830 | 123,190 | 14.52 |
|  | S. D. Wood | 54,900 | 1,219,850 | -0- | 1,274,750 | 756,560 | 373,490 | 1,130,050 | 144,700 | - |
|  | Tall Oil | 24,700 | 419,960 | -0- | 444,660 | 303,490 | 97,380 | 400,870 | 43,790 | - |
|  | Total | 251,120 | 2,009,960 | 350 | 2,261,430 | 1,322,160 | 627,590 | 1,949,750 | 311,680 | - |
| 1961 | Gum | 123,190 | 474,500 | 420 3/ | 598,110 | 265,560 | 153,310 | 418,870 | 179,240 | 11.95 |
|  | S. D. Wood | 144,700 | 1,105,410 | 3,000 3/ | 1,253,110 | 778,530 | 316,680 | 1,095,210 | 157,900 | - |
|  | Tall Oil | 43,790 | 471,150 | -0- | 514,940 | 318,580 | 73,220 | 391,800 | 123,140 | - |
|  | Total | 311,680 | 2,051,060 | 3,420 | 2,366,160 | 1,362,670 | 543,210 | 1,905,880 | 460,280 | - |
| 1962 | Gum | 179,240 | 492,890 | 500 3/ | 672,630 | 225,380 | 91,050 | 316,430 | 356,200 | 11.05 |
|  | S. D. Wood | 157,900 | 1,093,770 | 8,680 3/ | 1,260,350 | 741,150 | 344,110 | 1,085,260 | 175,090 | - |
|  | Tall Oil | 123,140 | 477,600 | -0- | 600,740 | 358,880 | 83,930 | 442,810 | 157,930 | - |
|  | Total | 460,280 | 2,064,260 | 9,180 | 2,533,720 | 1,325,410 | 519,090 | 1,844,500 | 689,220 | - |
| 1963 | Gum | 356,200 | 458,960 | 2,112 | 817,272 | 184,502 | 64,700 | 249,202 | 568,070 | 11.00 |
|  | S. D. Wood | 175,090 | 1,098,050 | 8/ | 1,273,140 | 743,980 | 318,560 | 1,062,540 | 210,600 | - |
|  | Tall Oil | 157,930 | 527,930 | 8/ | 685,860 | 420,530 | 101,290 | 521,820 | 164,040 | - |
|  | Total | 689,220 | 2,084,940 | 2,112 | 2,776,272 | 1,349,012 | 484,550 | 1,833,562 | 942,710 | - |
| 1964 (Est.) | Gum | 568,000 | 405,000 | 2,000 | 975,000 | 170,000 | 60,000 | 230,000 | 745,000 | - |
|  | S. D. Wood | 211,000 | 1,020,000 | 8/ | 1,231,000 | 735,000 | 325,000 | 1,060,000 | 171,000 | - |
|  | Tall Oil | 164,000 | 585,000 | 8/ | 749,000 | 450,000 | 110,000 | 560,000 | 189,000 | - |
|  | Total | 943,000 | 2,010,000 | 2,000 | 2,955,000 | 1,355,000 | 495,000 | 1,850,000 | 1,105,000 | - |
|  | TURPENTINE (50 gal. bbls.) |  |  |  |  |  |  |  |  | $ Per Gal. 4/ |
| 1958 | Gum | 42,880 | 120,300 | 22,150 | 185,330 | 121,900 | 30,100 | 152,000 | 33,330 | .513 |
|  | S. D. Wood | 69,000 5/ | 172,600 | -0- | 241,600 | 153,870 | 25,730 | 179,600 | 62,000 5/ | - |
|  | Sulphate | 39,220 5/ | 315,340 | -0- | 354,560 | 299,310 | 16,680 | 315,990 | 38,570 5/ | - |
|  | Total | 151,100 | 608,240 | 22,150 | 781,490 | 575,080 | 72,510 | 647,590 | 133,900 | - |
| 1959 | Gum | 33,330 | 107,400 | 15,440 | 156,170 | 94,250 | 28,970 | 123,220 | 32,950 | .534 |
|  | S. D. Wood | 62,000 5/ | 175,950 | -0- | 237,950 | 116,460 | 21,490 | 137,950 | 100,000 5/ | - |
|  | Sulphate | 38,570 5/ | 353,400 | -0- | 391,970 | 318,020 | 11,420 | 329,440 | 62,530 5/ | - |
|  | Total | 133,900 | 636,750 | 15,440 | 786,090 | 528,730 | 61,880 | 590,610 | 195,480 | - |
| 1960 | Gum | 32,950 | 118,950 | 15,570 | 167,470 | 92,150 | 23,200 | 115,350 | 52,120 | .479 |
|  | S. D. Wood | 100,000 5/ | 162,880 | -0- | 262,880 | 136,990 | 27,890 | 164,880 | 98,000 5/ | - |
|  | Sulphate | 62,530 5/ | 322,940 | -0- | 385,470 | 293,630 | 30,660 | 324,290 | 61,180 5/ | - |
|  | Total | 195,480 | 604,770 | 15,570 | 815,820 | 522,770 | 81,750 | 604,520 | 211,300 | - |
| 1961 | Gum | 52,120 | 152,810 | 15,220 | 220,150 | 107,960 | 47,120 | 155,080 | 65,070 | .245 |
|  | S. D. Wood | 98,000 5/ | 151,470 | -0- | 249,470 | 154,710 | 23,720 | 178,430 | 71,040 5/ | - |
|  | Sulphate | 61,180 5/ | 332,830 | -0- | 394,010 | 283,260 | 11,370 | 294,630 | 99,380 5/ | - |
|  | Total | 211,300 | 637,110 | 15,220 | 863,630 | 545,930 | 82,210 | 628,140 | 235,490 | - |
| 1962 | Gum | 65,070 | 152,100 | 12,910 | 230,080 | 102,780 | 58,320 | 161,100 | 68,980 | .201 |
|  | S. D. Wood | 71,040 5/ | 152,610 | -0- | 223,650 | 131,920 6/ | 26,420 | 158,340 | 65,310 | - |
|  | Sulphate | 99,380 5/ | 348,350 | -0- | 447,730 | 351,700 6/ | 15,630 | 367,330 | 80,400 | - |
|  | Total | 235,490 | 653,060 | 12,910 | 901,460 | 586,400 | 100,370 | 686,770 | 214,690 | - |
| 1963 | Gum | 68,980 | 140,520 | 13,900 | 223,400 | 99,230 | 91,820 | 191,050 | 32,350 | .339 |
|  | S. D. Wood | 65,310 | 157,480 | -0- | 222,790 | 117,700 | 40,000 | 157,700 | 65,090 | - |
|  | Sulphate | 80,400 | 375,530 | -0- | 455,930 | 364,880 | 31,450 | 396,330 | 59,600 | - |
|  | Total | 214,690 | 673,530 | 13,900 | 902,120 | 581,810 | 163,270 | 745,080 | 157,040 | - |
| 1964 (Est.) | Gum | 32,000 | 125,000 | 14,000 | 171,000 | 87,000 | 55,000 | 142,000 | 29,000 | - |
|  | S. D. Wood | 65,000 | 145,000 | -0- | 210,000 | 140,000 | 30,000 | 170,000 | 40,000 | - |
|  | Sulphate | 60,000 | 395,000 | -0- | 455,000 | 370,000 | 30,000 | 400,000 | 55,000 | - |
|  | Total | 157,000 | 665,000 | 14,000 | 836,000 | 597,000 | 115,000 | 712,000 | 124,000 | - |

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1/ These are gross stocks, including quantities sold and awaiting shipment. They include price support stocks.

2/ Price in drums f.o.b. production points.

3/ Estimated allocation, as between S. D. and gum rosin, of total rosin imports reported by Bureau of the Census.

4/ F.o.b. tank cars at production points.

5/ Estimated allocation, as between S. D. and sulphate turpentine stocks, of total wood turpentine stocks reported by Crop Reporting Board.

6/ Estimated allocation, as between S. D. and sulphate turpentine consumption, of total apparent consumption of wood turpentine reported by Crop Reporting Board.

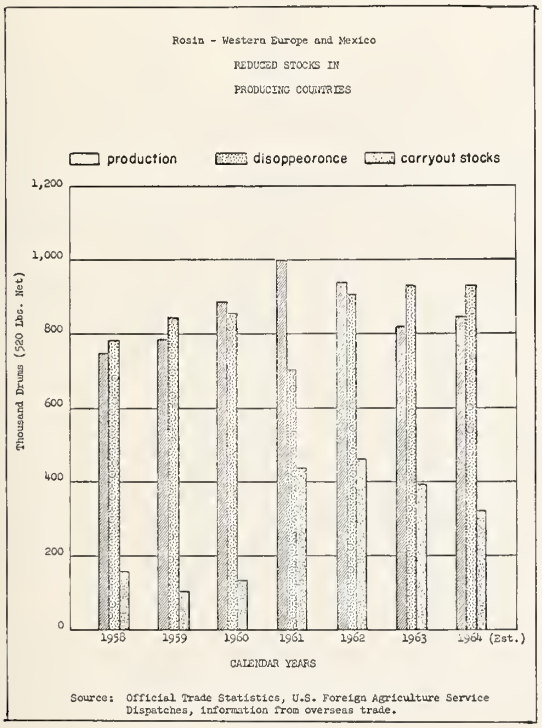
7/ Estimated

8/ If any, included under gum.

Source: Reports of Crop Reporting Board, and Agricultural Stabilization and Conservation Service, U.S.D.A., and Bureau of the Census, U. S. Department of Commerce.

However, continuing shift to and more efficient utilization of fortified rosin size, as well as increasing competition from processed tall oil as an emulsifier in synthetic rubber, tend partly to restrict gains in rosin utilization. Otherwise, consumption is rising in adhesives, declining in protective coatings, and more or less stable in other end uses. In the long term, increased domestic disappearance of rosin in current end uses is likely to be gradual with adhesives and paper size showing the most promise. The tendency of industrialized countries to import rosin rather than modified rosin continues to restrain United States rosin usage while sustaining exports.

Little change is expected in United States rosin exports. Rosin production in 1964 is increasing above low 1963 levels in Portugal, France and Greece. Mexican production, with steam distilled operations discontinued, will be significantly lower. Not much change is expected in Spanish output (See table 2 and figure 2). Production of tall oil rosin developing rapidly in Sweden and Finland and being initiated in the Netherlands is likely to continue its upward trend. Disappearance in producing countries, however, continues substantially in excess of production. Stocks in these countries next January 1, although still above the longterm post World War II average, will be at their lowest since January 1, 1961. Consumer stocks are being replenished overseas in anticipation of higher prices.


Rosin - Western Europe and Mexico

REDUCED STOCKS IN

PRODUCING COUNTRIES

Source: Official Trade Statistics, U.S. Foreign Agriculture Service Dispatches, information from overseas trade.

Figure 2

Considering ample supplies of rosin overseas and substantially lower foreign prices, it is remarkable that United States exports, overall, have been comparitively well-maintained. In part, this results from utilization of United States rosin at plants constructed by United States firms abroad and reflects substitution of rosin imports for imports of modified rosins.

Utilization of rosin overseas has not kept pace with increased industrial activity, mainly because of the rapid and continuing conversion to fortified paper size. At present, rosin size utilization abroad is estimated at 9 pounds per short ton of paper and board and further reduction is anticipated. However, foreign output of paper and board is expected to increase 35 to 40 percent by 1970. If Rosin size application rate reduces to 8 pounds, rosin paper size consumption abroad should increase about 20 percent by 1970. Increased utilization of rosin is expected in SBR rubber, output of which (in contrast with the stabilized United States situation) is expected to treble by 1970.

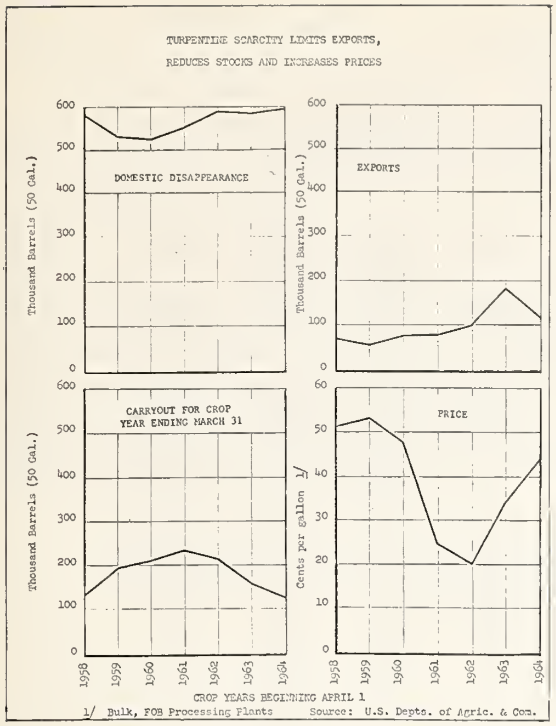
Assuming continued diminution of price differences between United States and other rosins, the export market holds promise for continued substantial absorption of United States rosin.

## Turpentine requirements

Industrial utilization of turpentine is increasing at the expense of exports and retail sales. Disappearance of United States turpentine will be lower in 1964 as compared with 1963 mainly because of an estimated 66, 000 barrel reduction in supplies. An anticipated 25 to 30 percent decrease in exports will more than offset a slight rise in domestic consumption (see table 1 and figure 3). Barring further substantial price increases, domestic turpentine consumption may be at a record level. Expanding industrial utilization should offset a sizeable reduction in retail distribution for solvent purposes.

TABLE 2 - Naval Stores supply and distribution, Mexico and major producing countries in Western Europe, calendar years 1958-64
ROSIN (Thousand Drums of 520 Lbs. Net)

| | SUPPLY | | | | DISTRIBUTION | | | |
|---|---|---|---|---|---|---|---|---|
| Commodity, Country and Year | Carry-in | Production | Imports | Total | Exports | Domestic Disappearance | Total | Carry-out |
| France: 1/ | | | | | | | | |
| 1958 | 42.0 | 170.7 | 1.7 | 214.4 | 20.4 | 154.7 | 175.1 | 39.3 |
| 1959 | 39.3 | 183.9 | 1.0 | 224.2 | 55.6 | 148.9 | 204.5 | 19.7 |
| 1960 | 19.7 | 174.6 | .7 | 195.0 | 34.5 | 135.5 | 170.0 | 25.0 |
| 1961 | 25.0 | 192.0 | 5.4 | 222.4 | 7.4 | 115.4 | 122.8 | 99.6 |
| 1962 2/ | 99.6 | 175.5 | 10.4 | 285.5 | 33.6 | 179.8 | 213.4 | 72.1 |
| 1963 2/ | 72.1 | 135.7 | 26.3 | 234.1 | 49.8 | 133.4 | 183.2 | 50.9 |
| 1964 (estimated) | 50.9 | 148.4 | 5.7 | 205.0 | 25.0 | 135.0 | 160.0 | 45.0 |
| Greece: | | | | | | | | |
| 1958 | 36.5 | 95.0 | 0 | 131.5 | 98.5 | 4.2 | 102.7 | 28.8 |
| 1959 | 28.8 | 91.6 | 0 | 120.4 | 98.3 | 3.0 | 101.3 | 19.1 |
| 1960 | 19.1 | 111.2 | 1.2 | 131.5 | 93.5 | 6.4 | 99.9 | 31.6 |
| 1961 | 31.6 | 131.6 | 0 | 163.2 | 127.6 | 7.6 | 135.2 | 28.0 |
| 1962 2/ | 28.0 | 99.5 | 0 | 127.5 | 99.4 | 9.0 | 108.4 | 19.1 |
| 1963 2/ | 19.1 | 84.8 | 0 | 103.9 | 51.7 | 10.6 | 62.3 | 41.6 |
| 1964 (estimated) | 41.6 | 97.5 | 0 | 139.1 | 84.8 | 10.9 | 95.7 | 43.4 |
| Mexico: | | | | | | | | |
| 1958 | 29.7 | 140.0 | 0 | 169.7 | 81.4 | 67.3 | 148.7 | 21.0 |
| 1959 | 21.0 | 142.9 | .5 | 164.4 | 75.8 | 59.4 | 135.2 | 29.2 |
| 1960 | 29.2 | 169.6 | .6 | 199.4 | 113.1 | 59.4 | 172.5 | 26.9 |
| 1961 | 26.9 | 184.4 | .5 | 211.8 | 120.2 | 53.0 | 173.2 | 38.6 |
| 1962 | 38.6 | 205.5 | .1 | 244.2 | 148.0 | 45.3 | 193.3 | 50.9 |
| 1963 (preliminary) | 50.9 | 195.0 | .1 | 246.0 | 172.0 | 40.0 | 212.0 | 34.0 |
| 1964 (estimated) | 34.0 | 166.0 | 0 | 200.0 | 135.0 | 40.0 | 175.0 | 25.0 |
| Portugal: | | | | | | | | |
| 1958 | 55.9 | 208.8 | 0 | 264.7 | 193.6 | 11.8 | 205.4 | 59.3 |
| 1959 | 59.3 | 225.8 | 0 | 285.1 | 244.5 | 12.6 | 257.1 | 28.0 |
| 1960 | 28.0 | 259.4 | 0 | 287.4 | 244.4 | 5.0 | 249.4 | 38.0 |
| 1961 | 38.0 | 319.8 | 0 | 357.8 | 134.1 | 8.6 | 142.7 | 215.1 |
| 1962 2/ | 215.1 | 279.1 | 0 | 494.2 | 236.0 | 15.9 | 251.9 | 242.3 |
| 1963 2/ | 242.3 | 266.0 | 0 | 508.3 | 313.9 | 13.6 | 327.5 | 180.8 |
| 1964 (estimated) | 180.8 | 297.0 | 0 | 477.8 | 340.0 | 14.0 | 354.0 | 123.8 |
| Spain: | | | | | | | | |
| 1958 | 25.4 | 133.6 | 0 | 159.0 | 62.8 | 86.2 | 149.0 | 10.0 |
| 1959 | 10.0 | 142.4 | 0 | 152.4 | 74.7 | 69.7 | 144.4 | 8.0 |
| 1960 | 8.0 | 171.7 | 0 | 179.7 | 80.5 | 84.2 | 164.7 | 15.0 |
| 1961 | 15.0 | 172.1 | 0 | 187.1 | 48.9 | 81.0 | 129.9 | 57.2 |
| 1962 2/ | 57.2 | 178.1 | 0 | 235.3 | 73.2 | 64.6 | 137.8 | 97.5 |
| 1963 2/ | 97.5 | 137.8 | 0 | 235.3 | 86.2 | 60.0 | 146.2 | 89.1 |
| 1964 (estimated) | 89.1 | 140.0 | 0 | 229.1 | 90.0 | 55.0 | 145.0 | 84.1 |
| TOTAL: | | | | | | | | |
| 1958 | 189.5 | 748.1 | 1.7 | 939.3 | 456.7 | 324.2 | 780.9 | 158.4 |
| 1959 | 158.4 | 786.6 | 1.5 | 946.5 | 548.9 | 293.6 | 842.5 | 104.0 |
| 1960 | 104.0 | 886.5 | 2.5 | 993.0 | 566.0 | 290.5 | 856.5 | 136.5 |
| 1961 | 136.5 | 999.9 | 5.9 | 1,142.3 | 438.2 | 265.6 | 703.8 | 438.5 |
| 1962 | 438.5 | 937.7 | 10.5 | 1,386.7 | 590.2 | 314.6 | 904.8 | 481.9 |
| 1963 | 481.9 | 819.3 | 26.4 | 1,327.6 | 673.6 | 257.6 | 931.2 | 396.4 |
| 1964 (estimated) | 396.4 | 848.9 | 5.7 | 1,251.0 | 674.8 | 254.9 | 929.7 | 321.3 |


TURPENTINE SCARCITY LIMITS EXPORTS, REDUCES STOCKS AND INCREASES PRICES

1/ Bulk, FOB Processing Plants Source: U.S. Depts. of Agric. & Com.

Figure 3

Turpentine is used industrially through fractionation mainly into alpha and beta pinene. About one-fourth of these fractions are exported, the remainder are absorbed domestically. Alpha pinene goes mainly into synthetic pine oil and insecticides. Requirements for synthetic pine oil tend to increase as availability of natural pine oil declines with SD production. At present, about two-thirds of the United States pine oil output is natural, about one-third synthetic. Demand for insecticides is well-maintained. The main outlet for beta pinene and one that is expanding rapidly is in polyterpene resins for pressure sensitive tapes and other purposes. Scarcity of turpentine derives mainly from demand for the beta fraction which is found only in gum and sulfate wood turpentine. Because demand for beta pinene for terpene resins exceeds supply, actual and potential users are turning to polyterpene resins based on alpha pinene, or modified rosin.

Outlook for turpentine requirements, at price levels reasonable to consumers as well as to producers, is favorable particularly in view of results of intensive new use research initiated when the price of turpentine was far below the current level.

Abroad, about 60 percent of turpentine utilization is for solvent purposes. However, its use as a chemical intermediate has been increasing. Production of turpentine overseas in calendar year 1964 (other than in Communist countries) is estimated at about 5 percent above 1963 output and about the same as that for 1962. Carryin stocks are lower. Actually, foreign export availabilities in 1964 calendar year are estimated at about 187 thousand barrels, which is about in line with the average for the past 5 years (See table 3).

## Stocks

At the estimated volumes of production and disappearance, the domestic rosin carryout March 31, 1965, should rise about 17 percent and approximate 1.1 million drums, the highest since March 31, 1943. Increasing stocks of gum and tall oil rosin will far offset the lower SD carryout. Gum rosin price support collateral, increasing about 150 thousand drums, will constitute about 60 percent of the carryover. Part of the loan rosin, particularly WW grade, may move out before new crop rosin is available next spring. As in the past, these price support stocks may prove a useful backlog.

Barring substantial price rises, the turpentine carryout March 31, 1965 may be the lowest in 18 years.

## Prices

United States gum rosin prices have been relatively stable for more than 2 years. Other types of rosin, especially tall oil rosin, are being sold at lower prices, particularly for export. Prices of foreign rosins remain considerably lower than domestic gum rosin, but the difference is narrowing. April 1, 1964, rosin from Western European countries was quoted at prices ranging from $2.60 to $4.40 per 100 pounds less than the United States gum rosin. In September the range was $1.80 to $3.50. Further reduction in these price differentials is expected as stocks in foreign producing countries decline.

The market situation of United States gum rosin in relation to other United States

TABLE 3 - Naval Stores supply and distribution, Mexico and major producing countries in Western Europe, calendar years 1958-64 - Continued
TURPENTINE (Thousand 50-Gal. Barrels)

| Commodity, Country and Year | SUPPLY | | | | DISTRIBUTION | | | |
|---|---|---|---|---|---|---|---|---|
| | Carry-in | Production | Imports | Total | Exports | Domestic Disappearance | Total | Carry-out |
| Findland: | | | | | | | | |
| 1958 | 5.4 | 41.5 | 0 | 46.9 | 18.4 | 24.5 | 42.9 | 4.0 |
| 1959 | 4.0 | 40.0 | .5 | 44.5 | 14.4 | 27.0 | 41.4 | 3.1 |
| 1960 | 3.1 | 44.1 | 1.0 | 48.2 | 12.0 | 31.9 | 43.9 | 4.3 |
| 1961 | 4.3 | 51.8 | .3 | 56.4 | 22.4 | 28.3 | 50.7 | 5.7 |
| 1962 | 5.7 | 52.6 | .4 | 58.7 | 24.0 | 30.5 | 54.5 | 4.2 |
| 1963 (preliminary) | 4.2 | 61.8 | 1.7 | 67.7 | 29.7 | 34.0 | 63.7 | 4.0 |
| 1964 (estimated) | 4.0 | 64.9 | .5 | 69.4 | 30.4 | 35.0 | 65.4 | 4.0 |
| France: 1/ | | | | | | | | |
| 1958 | 5.9 | 67.4 | 28.4 | 101.7 | 1.2 | 95.7 | 96.9 | 4.8 |
| 1959 | 4.8 | 71.6 | 28.5 | 104.9 | 1.1 | 99.1 | 100.2 | 4.7 |
| 1960 | 4.7 | 68.1 | 23.7 | 96.5 | 1.8 | 79.0 | 80.8 | 15.7 |
| 1961 | 15.7 | 74.4 | 33.4 | 123.5 | 1.1 | 102.9 | 104.0 | 19.5 |
| 1962 2/ | 19.5 | 67.3 | 31.9 | 118.7 | 1.0 | 113.9 | 114.9 | 3.8 |
| 1963 (preliminary) | 3.8 | 52.1 | 59.9 | 115.8 | 1.5 | 108.8 | 110.3 | 5.5 |
| 1964 (estimated) | 5.5 | 60.0 | 50.0 | 115.5 | 0 | 110.0 | 110.0 | 5.5 |
| Greece: | | | | | | | | |
| 1958 | 12.7 | 37.2 | 0 | 49.9 | 14.8 | 21.4 | 36.2 | 13.7 |
| 1959 | 13.7 | 36.1 | 0 | 49.8 | 23.2 | 23.0 | 46.2 | 3.6 |
| 1960 | 3.6 | 41.9 | .5 | 46.0 | 20.5 | 23.0 | 43.5 | 2.5 |
| 1961 | 2.5 | 49.6 | 0 | 52.1 | 9.2 | 27.5 | 36.7 | 15.4 |
| 1962 2/ | 15.4 | 37.5 | 0 | 52.9 | 18.2 | 30.6 | 48.8 | 4.1 |
| 1963 (preliminary) | 4.1 | 33.7 | 0 | 37.8 | .4 | 35.4 | 35.8 | 2.0 |
| 1964 (estimated) | 2.0 | 36.9 | 0 | 38.9 | 1.9 | 35.0 | 36.9 | 2.0 |
| Mexico: | | | | | | | | |
| 1958 | 2.8 | 42.9 | * | 45.7 | 30.6 | 7.5 | 38.1 | 7.6 |
| 1959 | 7.6 | 47.5 | .1 | 55.2 | 35.2 | 9.3 | 44.5 | 10.7 |
| 1960 | 10.7 | 55.1 | .1 | 65.9 | 37.2 | 9.2 | 46.4 | 19.5 |
| 1961 | 19.5 | 60.0 | 1.2 | 80.7 | 52.3 | 9.3 | 61.6 | 19.1 |
| 1962 | 19.1 | 66.1 | .7 | 85.9 | 42.9 | 18.3 | 61.2 | 24.7 |
| 1963 (preliminary) | 24.7 | 66.0 | * | 90.7 | 32.6 | 36.1 | 68.7 | 22.0 |
| 1964 (estimated) | 22.0 | 55.0 | * | 77.0 | 35.0 | 30.0 | 65.0 | 12.0 |
| Portugal: | | | | | | | | |
| 1958 | 30.1 | 69.1 | 0 | 99.2 | 41.9 | 20.7 | 62.6 | 36.6 |
| 1959 | 36.6 | 76.1 | 0 | 112.7 | 54.1 | 18.5 | 72.6 | 40.1 |
| 1960 | 40.1 | 84.3 | 0 | 124.4 | 59.8 | 23.4 | 83.2 | 41.2 |
| 1961 | 41.2 | 107.1 | 0 | 148.3 | 73.9 | 31.7 | 105.6 | 42.7 |
| 1962 2/ | 42.7 | 88.4 | 0 | 131.1 | 54.1 | 34.6 | 88.7 | 42.4 |
| 1963 (preliminary) | 42.4 | 88.3 | 0 | 130.7 | 65.0 | 30.4 | 95.4 | 35.3 |
| 1964 (estimated) | 35.3 | 98.1 | 0 | 133.4 | 75.0 | 31.0 | 106.0 | 27.4 |
| Spain: | | | | | | | | |
| 1958 | 18.4 | 55.1 | 0 | 73.5 | 0 | 61.3 | 61.3 | 12.2 |
| 1959 | 12.2 | 55.1 | 0 | 67.3 | 4.2 | 47.8 | 52.0 | 15.3 |
| 1960 | 15.3 | 70.4 | 0 | 85.7 | 7.3 | 66.2 | 73.5 | 12.2 |
| 1961 | 12.2 | 71.0 | 0 | 83.2 | .9 | 70.1 | 71.0 | 12.2 |
| 1962 | 12.2 | 73.5 | 0 | 85.7 | 0 | 73.5 | 73.5 | 12.2 |
| 1963 (preliminary) | 12.2 | 55.1 | 0 | 67.3 | 0 | 60.0 | 60.0 | 7.3 |
| 1964 (estimated) | 7.3 | 59.0 | 0 | 66.3 | 0 | 60.0 | 60.0 | 6.3 |
| Sweden: | | | | | | | | |
| 1958 | 6.0 | 51.4 | 3.8 | 61.2 | 44.4 | 11.8 | 56.2 | 5.0 |
| 1959 | 5.0 | 56.3 | 3.8 | 65.1 | 45.2 | 15.9 | 61.1 | 4.0 |
| 1960 | 4.0 | 63.1 | 3.4 | 70.5 | 48.4 | 16.1 | 64.5 | 6.0 |
| 1961 | 6.0 | 63.4 | 2.7 | 72.1 | 42.1 | 24.0 | 66.1 | 6.0 |
| 1962 | 6.0 | 54.5 | 2.7 | 63.2 | 42.2 | 16.0 | 58.2 | 5.0 |
| 1963 (preliminary) | 5.0 | 62.7 | 3.2 | 70.9 | 39.5 | 26.4 | 65.9 | 5.0 |
| 1964 (estimated) | 5.0 | 65.0 | 3.0 | 73.0 | 45.0 | 23.0 | 68.0 | 5.0 |
| TOTAL: | | | | | | | | |
| 1958 | 81.3 | 364.6 | 32.2 | 478.1 | 151.3 | 242.9 | 394.2 | 83.9 |
| 1959 | 83.9 | 382.7 | 32.9 | 499.5 | 177.4 | 240.6 | 418.0 | 81.5 |
| 1960 | 81.5 | 427.0 | 28.7 | 537.2 | 187.0 | 248.8 | 435.8 | 101.4 |
| 1961 | 101.4 | 477.3 | 37.6 | 616.3 | 201.9 | 293.8 | 495.7 | 120.6 |
| 1962 | 120.6 | 439.9 | 35.7 | 596.2 | 182.4 | 317.4 | 499.8 | 96.4 |
| 1963 | 96.4 | 419.7 | 64.8 | 580.9 | 168.7 | 331.1 | 499.8 | 81.1 |
| 1964 (estimated) | 81.1 | 438.9 | 53.5 | 573.5 | 187.3 | 324.0 | 511.3 | 62.2 |

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1/ Production and stocks on crop year basis, exports and imports by calendar year.
2/ Revised
* Less than 0.05

Source: Official trade statistics, foreign trade sources, and U.S. Foreign Agricultural Service dispatches.

types and foreign rosins has existed in varying degree for several decades.

The point is that, because of high labor costs, domestic gum rosin cannot be produced as cheaply as domestic tall oil rosin, a byproduct of the kraft paper mills, or even steam distilled wood rosin which involves relatively little labor. Similarly, because of higher production costs relative to Portuguese and Spanish rosins and greater shipping distances and costs, European selling prices necessarily are higher for United States gum rosin than for rosin of foreign origins. As stated, this price differential, while substantial, has been declining and is expected to continue to decline.

Thus, traditionally, United States gum rosin has been a residual source of supply both here and abroad. Intensive research being conducted by USDA on reducing production costs of crude pine gum and on developing new chemicals from gum and new uses for rosin may, in the future, enhance the competitive position of United States gum rosin vis-a-vis foreign rosins and other types of domestic rosin.

The price of gum turpentine today is 13 cents per gallon over the price at this time a year ago. If the rise continues, significant curtailment may be expected in both domestic and export markets.

# PROSPECTS FOR THE SUCCESS OF NAVAL STORES STABILIZATION EFFORTS

(Worldwide Naval Stores Picture)

by

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At this time last year we expected 1963-64 rosin production and consumption in the Western world to be in balance. This did not come true. Stocks of the 4 major Western European producing countries were reduced by about 50, 000 drums, but our own rosin stocks increased by 253, 000 drums. Therefore, about 200, 000 drums were added to Western inventories.

About the same amount probably will be added this season. Western European production will be about 15 percent above last season's; nevertheless, the entire production is likely to be sold, and thus, European stocks might remain unchanged. On the other hand, it looks as if we here would add another 200, 000 drums to our stockpile this season, bringing it very close to 1, 150, 000 drums.

In terms of production, our stocks would equal about 55 percent of our 1964-65 production, and the European stocks about 37 percent of their 1964-65 production. In terms of disappearance, total Western stocks would equal 6-1/2 months supply, 4-1/3 months supply in Europe, and 7-1/2 months supply here. Breaking our own stocks down by categories, we shall have on hand a 2 months' supply of wood rosin, a 4-1/2 months supply of tall oil rosin, and a 3-1/2 years supply of gum rosin at the present rate of disappearance. There is no easy or quick way to bring rosin supply and demand into balance. There seems to be little hope for an increase of rosin consumption. It has remained quite steady these last few years; it has never recovered the ground it lost after the price madness of 1960, and there are no signs pointing towards an improvement of demand.

A voluntary and meaningful reduction of production is unlikely. Our own gum and wood rosin production this season will be lower than last season's and probably will be still lower next season; but tall oil rosin production has increased steadily and will continue to increase as long as crude tall oil remains available as a byproduct of paper manufacture, and, therefore, a cheap raw material. It would be unrealistic to expect anything but a continued increase of tall oil rosin production in this country and abroad.

The Western European countries are unlikely to reduce their production voluntarily as long as it can be sold. Portuguese and Spanish rosins brought very low prices last season, nevertheless, both countries will produce more this season. Consequently, they must have made money even at last season's low prices, or at least expect to make money this season. Why then should they reduce their productions voluntarily? France and Greece have been pushing for an International Agreement to limit production and stabilize prices. As now proposed the Agreement would require only Portugal and possibly Spain to limit their productions, while France and Greece would hardly be affected; the chances of enactment, therefore, seem slim. Furthermore, any such agreement could not be effective without United States participation, and this is not permitted under our laws.

A voluntary reduction of rosin production seems doubtful. This still leaves recourse to forced measures as, for instance, the reinstatement of the CCC (Commodity Credit Corporation) Export Bid System, or discontinuance of our price support program for rosin. Reinstatement of the CCC Export Bid System would hardly stimulate consumption; initially, it would amount only to a transfer of rosin stocks from CCC yards to other yards and plants in this country and abroad. Whether ultimately the CCC Export Bib System would lead to a reduction of Western rosin production would depend on how much financial support CCC is prepared to give the program. Discontinuation of our price support program would reduce gum rosin production in this country drastically. It would have only a limited effect on the production of other types and origins of rosin, because American gum rosin has ceased to be the determining factor in Western rosin production, consumption, and pricing. George Varn will have much more to say on this subject.

As I said before, there is no easy or quick way to bring rosin demand and supply into balance. Turpentine production this season will be higher than last season's, because Europe will produce more gum turpentine and this country more sulfate turpentine. The tight supply position is primarily due to the fact that our stocks decreased in the course of last season by about 58,000 barrels, and neither we, nor the other producing countries, have any reserves left to draw on. I am not certain whether the tight position is due to increased demand. It is true, of course, that increasing quantities of turpentine are required for chemical uses. On the other hand, demand for solvent uses is declining, particularly in Europe where gum turpentine is no longer competitive with mineral spirits up to the 30 cents level as it was. I have not been able to find any reliable figures which would indicate whether the increased demand for turpentine for chemical uses more than offsets the decrease in demand for solvent uses. Furthermore, it seems that turpentine prices have now reached a critical point, even for some of the chemical uses. Any further increase of turpentine prices would force the prices of some of the fractionation products up to such an extent that their sales volume might suffer. We can only hope that turpentine prices will not follow the disastrous trail which rosin prices took 4 years ago.

## PROSPECTS FOR THE SUCCESS OF NAVAL STORES STABILIZATION EFFORTS THROUGH LOAN PROGRAM AND EXPORTS

by

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Varn Trading Co.
Jacksonville, Fla.

A short 4 years ago rosin prices were peaking out after a sustained 2 year increase during which time they approximately doubled. Consumers, concerned with increasing prices and bombarded on all sides by dire predictions of shortages, attempted to lay in all the inventory possible, almost regardless of cost. At the same time, they began frantic efforts to find methods of cutting rosin consumption by economies of usage or by substitution of other materials. Gum rosin producers throughout 1960, and up until the spring of 1961 were called upon at meetings throughout the belt to increase production. Thus, misled by the experts, by the frantic demands for rosin, by timber owners seeking the suddenly profitable stumpage from naval stores, and finally led on by the high level prices, gum rosin producers began an equally frenetic hanging of cups. When the smoke cleared early in 1961, three things were apparant. First, there wasn't any real shortage of rosin and never had been; the rosin was just being transferred from Commodity Credit stocks into the hands of consumers and dealers and was being accumulated in dead storage. Second, the consumer had been successful beyond belief in replacing rosin one way or another. Third, producers here and abroad had been almost unbelievably successful in increasing production. Whether we like it or not, all of us in this industry must share in part the blame for the sorry mess that has resulted. The disparity between production and consumption of all rosins, intensified by the inevitable increase in tall oil rosin production, has led to a steady buildup of stocks over the past 4 years, and a consequent continued pressure on prices.

Members of the American gum industry, to whom were available the only legally permissable mechanism for attempting price stabilization, made continued efforts to shore up the price structure within the framework of the government loan program and voluntary producer/processor cooperation. The efforts having some measure of success at first, but finally fell apart from the combined weight of increased stocks, the lower prices of competitive rosins, and finally from the desire of some members of the industry to make a fast buck at the expense of others. In any event, eventual total success, obviously, could be achieved only by reducing worldwide production of rosin to a level somewhat below demand requirements until excess stocks could be worked off, because even with the loan program on American gum resin, complete isolation from world commerce would not be possible indefinitely. Although there has been a steady decline in the production of American gum rosin and wood rosin, tall oil rosin production has continued to increase. This increase has more than offset the combined decline of gum and wood rosin production in this country. Foreign rosin production, which with its 1-year production cycle is considerable more flexible than American production. It first declined and then began to expand again, so that, as has been pointed out by Mr. Meyer, production in this current year will again probably exceed consumption on a worldwide basis by some 200, 000 drums or just about the amount going into the loan program here.

The majority of world rosin stocks are held in this country, and much interest has been expressed in the possibility of stabilizing prices, and production, by the use of these stocks. Specifically, this would appear to mean using stocks of American rosin for sale in export channels at such prices as would discourage further production increases abroad, thus bringing production and consumption more nearly into line. Practically speaking both because of legality and economics, this could only be done by the use of the large stocks of American gum rosin pledged under the loan program, which will probably approximate 700, 000 drums by the end of this current season. Methods most commonly mentioned have been the export bid system, used to dispose of rosin in a prior time of surplus, or some type of dual price system such as has been used for other agricultural commodities.

I do not believe that stabilization of rosin prices through export manipulations, whatever the name, is practical. There is considerable argument for the view that the entire loan program on American gum rosin, designed primarily for this purpose of stabilization, can no longer be justified either from the standpoint of economic cost or from a practical consideration of the chances of ultimate success, no matter what the cost. The loan program can effect stabilization only through its action on American gum rosin, and that industry, once the only source of rosin, declined in importance so much that in the past decade it was often described as "the tail which wagged the dog," and has now been cut off so close to the rear end of the animal that its movements are practically imperceptible.

Twenty-five years ago the world produced 1. 3 billion lb. of rosin, of which 955 million lb., or more than 70 percent, were produced in the United States. Of this amount nearly 550 million lb. were American gum rosin. 1964 production will probably approximate 1963, with a total of about 1.6 billion lb. in the free world, of which slightly more than 1 billion lb. will be total U.S. production. American gum rosin production will be barely 200 million lb. Thus, 25 years ago the American gum rosin industry produced 40 percent of the total rosin made in the world; today, it produces only about 12 percent. Of that amount one-half is not currently being used and is going into loan stocks.

To put it another way, 15 out of every 16 lb. of rosin consumed in the free world today is not American gum rosin. So I think we can all agree that if this tail did much wagging before it is about wound up as a pricing mechanism and thus as a stabilizer now.

Indeed, one might well ask, do we need a gum naval stores industry in this country at all? For the past 20 years consumption of rosin in the United States has been either remarkably stable, or going no where at all, depending upon one's point of view. Domestic consumption of all types of rosin has held within rather close limits of about 625 million lb. to 800 million lb., or about 1.2 million to 1.5 million drums, the variations corresponding generally to annual changes in economic industrial activities, with no pattern of long term growth whatever. The 1962 USDA "Outlook for Naval Stores", an excellent and thorough economic analysis of the industry, projected a very moderate increase in the consumption of all rosins in the United States from 1960 to 1970 of some 200,000 drums (from 1,409,000 to 1,606,000). Unfortunately, by 1963, despite an unparalleled period of economic prosperity, total rosin consumption had increased not one bit, and indeed all indications are that for 1964 total domestic consumption will actually be less than that of 1960. An outstanding reason for this is the paper industry. The report explicitly detailed 175,000 drums of increase, or most of the total, to the paper industry. However, even though from 1952 to 1963 the paper industry increased its consumption of rosin by some 120,000 drums, or about 30 percent during the same period, the tonnage output of the paper industry increased more than 50 percent--that is, from 24.4 million tons of paper, paper board, etc. to 38.9 million tons-- and the amount of rosin consumed per ton of paper and board actually fell precipitously from 11.8 lb per ton to 6.9 lb. per ton. Even though paper production itself has outgrown the rate predicted in the 1962 report, rosin consumption has not kept pace. The future trend in the paper industry appears to be for continued economies in the use of rosin size, or even replacement by non-resinous sizing material. And, in any event, expansion in the paper industry, as presently expected, will produce far more rosin than it will use. On the basis of present information, therefore, one would have to predict that 1970 usage of rosin in the U.S. would be considerably less than 1.6 million drums predicted, and quite possibly no more than the 1.4 million drums of 1960, in the absence of any growing demand for rosin in another industry which has so far eluded all searching.

If we use a somewhat optimistic figure of 1/2 million drums of American rosin for export requirements, a figure closely in line with current exporting, and with the USDA 1970 estimate, our yearly demands until 1970 would seem to be in the general area of 1.9 million drums annually.

In this current year, the wood naval stores industry and the tall oil rosin industry between them will produce close to 1,650,000 drums of rosin. This year tall oil rosin production alone will probably be about 600,000 drums, which will exceed the earlier predictions considerably. If the rate of increase is maintained, we should have about 850,000 drums annually by 1970. If wood rosin production is maintained at about 1 million drums per year until then, as the USDA report certainly seems to indicate, and if not one single pound of American gum rosin were produced after the end of this current season, wood and tall oil rosin production combined would leave only a theoretical deficit between production and consumption, both domestic and export, of some 200,000 drums of rosin in 1965, and this would decline to about 50,000 drums deficit by 1970. By the end of the current producing season there will be about 700,000 drums of gum rosin in loan stocks, so that one could say that if these loan stocks were used to make up this entire projected deficit every year, by 1970 we would still have 150,000 drums of rosin left in loan stocks. And this leaves out of consideration entirely the obvious fact that gum rosin production cannot be stopped overnight, and that there are in addition some 400,000 drums of available wood rosin and tall oil rosin stocks in addition to the loan stocks of gum rosin.

These are shocking figures, but on the basis of them one would be forced to conclude that if the American gum naval stores industry disappeared tomorrow its few remaining customers wouldn't miss it very much. Only some 200,000 drums of that rosin are entering into world commerce this year, and in a good many cases displacement by other rosins is simply a matter of convenience. Given the stocks of gum rosin, and industry research capabilities, there is not much doubt that modification of other rosins could be achieved to take the place of gum satisfactorily in plenty of time.

Many times in the past we have had over-supplies of rosin, but each time it was simply a question of how to split the cake, and how to adjust production temporarily. Never before has one of the products been derived from a raw material whose supply inevitably is going to increase, almost regardless of requirements for use, as tall oil will. In the past also, there are always some industry in which use of rosin was growing; Today I do not know of a single industry in which this is true. Beyond this, a large part of the research capabilities in the industry, which are extensive, have been directed towards making other rosins as good as gum, not towards developing new uses. This has been overwhelmingly successful, and there are relatively few uses today in which gum rosin has any decided economic advantages.

It is evident abroad, that foreign producers of gum rosin are able to produce it at levels considerably below current loan prices. Portuguese rosin, for example, delivers today in the United Kingdom at a 25 percent discount to American rosin. Although Portuguese producers say the returns are inadequate and that they are not making sufficient return on their investment, the fact nevertheless is that production has increased. And there is a lot of room for sufficient profitability between the present level of prices of foreign rosins and the loan price of American gum rosin, which simply does not return any profit to the American producer. It is unreasonable, therefore, to say that we are holding an umbrella over foreign production when their prices are so far below ours when they are competing successfully in the world market with other rosins and when they are not sending back cheap rosin to the U.S. So long as American gum rosin, worldwide, is entirely surplus production, as it is now, there appears little justification for using loan stocks of that rosin in an attempt to control world prices, even if such action would have results sufficient to justify the enormous cost--and this is highly questionable.

In cold fact, there is considerable doubt that the loan program can be justified at all, if the current information, and available facts are to be believed. As originally conceived, the program was designed to modify wide variations in price caused not only by natural variations in supply and demand, but by the extremities of these variations induced by operations in the market place, and the loan did a good job in this regard. The philosophy has altered, however, and it has come to be accepted that the loan program should be not a mechanism to smooth out abnormal and unnatural fluctuations in the natural price level, but instead should be a mechanism for keeping the gum naval stores industry alive, and therefore that the loan price should be set not in terms of what the product is worth on average in the market, but rather what it cost to produce it.

One can make a case for the continued support of agricultural production by government, even at some considerable annual expense, if the continued existence of that production is necessary either to the healthy condition of the economy as a whole; to the survival of the Nation in periods of emergency; or even, at least for a time, if it is of overwhelming importance to a particular section of the economy.

On none of these counts can gum rosin any longer qualify. I emphasize strongly, however, that this is not to suggest it would be either wise or fair for the loan to be discontinued abruptly. If any segment of agriculture, by reason of long range commitments, ever deserved reasonable notice, it is the gum industry, but unless there is some important evidence that has been misconstrued, or some changes in the offing of which we have no present knowledge, it would seem that this notice is considerably overdue. We are too much entangled with the program to get out of it by cutting it off overnight, nor should we have a "fire sale" of available stocks, but we should begin by clearly re-establishing a more proper basis for a limited continuance of the program; by an immediate industry-wide re-evaluation of all available facts and projections for the future; and if there are no important modifications, then inevitably there should be the orderly discontinuance of the program in order to minimize the cost to government and to the producer.

These are the facts as they exist today, and we must face them. But, I do not want to stop here lest you think there is no place for gum naval stores in the future forest economy--this is simply not true. To the forest owner, income from the naval stores operation on his land can be tremendously valuable, and the practical value may well increase if the present attempts to eliminate capital gains treatment on timber sales should succeed. Gum naval stores operations can give a considerable boost to the economy of agricultural areas. Finally the industry can provide work for relatively unskilled laborers who, as the future shapes up now, may be greatly in need of it. The conclusions prompted by consideration of the somewhat depressing statistics heretofore depend upon three main assumptions. The first of these is that the material produced by the gum naval stores industry must compete with those of the other naval stores industries, wood, and sulfate. The second assumption is that the cost of producing gum naval stores is essentially fixed at its present level, and the third assumption is that there are no large scale uses for rosin that can be developed. Concentrated research can possibly negate any of these assumptions, but research takes time, and our time, at least so far as the gum naval stores industry is concerned, has just about run out.

Each of the assumptions in turn raises a possibility. First, even at our present cost, it is possible that uses can be developed for gum oleoresin which cannot be satisfied by rosin. We all know that a considerable chemical change occurs in the distillation of rosin from gum. The isolation of the gum naval stores industry from competing products of lower cost by developing large uses for oleoresin, rather than rosin, as a raw material, could maintain a place for the industry even at its present price level. Second, concentrated research into basic physiology of the pine tree could develop methods for extending gum flow which would considerably reduce the cost of production, and thus possibly render gum rosin competitive with other materials. The third possibility is the development of additional large-scale uses for rosin itself.

But, we cannot continue to sit by and wait hopefully for something to turn up. Nor can we justify the continued existence of the industry, and the enormous amounts of money being spent on it by government in any of the eight or ten ways which government presently deals with gum rosin, simply because we are hopeful, and because something has always turned up in the past. In bald, cold, fact we are facing a future where our product is not going to be needed, where the price stabilization mechanism which almost alone has kept us in business is honestly and realistically in great jeopardy, and should be, and where our costs of production are too high to manufacture and sell the most important product we currently have available. The gum naval stores industry clearly faces the most serious challenge of its life, and if that challenge is not promptly and vigorously met, the flounderings of the industry will shortly turn into its death agonies, and it will not take another decade of complacent finger twiddling and behind sitting for that to happen. We have been bailed out too often by luck and by war--a poor combination on which to depend. We have little time left to revitalize an industry which has before, and could again, contribute much to the economy of our forest, our region, and the Nation.

# MARKETING NEW NAVAL STORES PRODUCTS

by

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In the marketing of new naval stores products we encounter, for the most part, the same problems that many of the other industries do. My remarks today, however, will be concerned with those aspects of marketing, which may be somewhat unique to our industry and relate in particular to some of our own experiences at Glidden.

New products may be classified as:

1. Products resulting from improvements of present products. Such products, it may be argued, are not really "new," but on the other hand, they may function or serve a purpose where the older products were not satisfactory or not applicable.

2. New products which constitute an extension of a present line. A present line of plasticizers, for example, may be supplemented by a new group which functions at lower temperatures.

3. New products that may be either new only to the company or entirely new to the industry. Since the problems associated with this third group are somewhat more unique, I will restrict my comments to such products.

Up until 6 years ago, our business in the terpene area consisted primarily in the marketing of basic terpenes and simple terpene derivatives already well established in the trade. These included alpha-pinene, beta-pinene, pine oil, and dipentene.

As a result of very extensive research over the past 20 years, processes have been developed for the manufacture of a number of 10-carbon compounds of importance such as flavor and perfume chemicals and intermediates. Included among the aroma chemicals were citronellol, geraniol, linalool, linalyl acetate, nerol, and hydroxycitonellal. With the exception of the last, all of these materials may be obtained directly from naturally occurring essential oils where they are found in admixture with other materials. Citronellol occurs as the main component of citronella oil. Geraniol is obtained from geranium and citronella oils. Linalool and linalyl acetate come from Bois de Rose and bergamot oil. Nerol is rather scarce in nature, occurring in oils of such limited or nonpractical source as to make its price commercially prohibitive.

In the introduction of these perfume chemicals to the market, the choice was posed of the use of the existing sales staff or of going to the outside. Neither the utilization of the present staff nor its expansion was considered practical since the customers for perfume chemicals were not being presently contacted nor was there sufficient knowledge of the industry and its problems to serve it effectively. In going to the outside, there was the possibility of acquisition of a company with an established marketing or sales organization for perfume chemicals or of entering into some sort of an exclusive arrangement with a distributor. Because of the rather limited line we had to offer and with the availability of an excellent distributor, the choice was made in favor of the distributor.

As in many industries, perfume manufacture is one steeped in tradition and one based on a formulating art which is uniquely the talent of a relatively few individuals. The perfumer is in a true sense an artist who combines fragrances much as a painter combines colors and shades to produce the total effect of a picture or portrait. More emphatically than the painter, however, the perfumer has a sensitivity and a prejudice which makes him much more exacting in his demands for perfection and achievement. In contrast to the painter, the perfumer is sheathed in an armor of uniqueness of expression which is quite often impenetrable. The perfumer speaks of "greenness," "bouquet," "lift," "roundness," "freshness," "top-notes," and other terms which really represent experiences rather than descriptions of odor. Translation of these terms into actual measurable properties of a product is in many cases impossible.

A chemically produced product by our best methods of analysis may be "pure" but the perfumer may reject it as unsatisfactory because of its lack of "bouquet" or "lift" or because it contains "off-notes." What he is really basing his rejection on is the comparison with the same product obtained from natural sources. The naturally derived material often contains traces of impurities undetectable by even the most sophisticated methods of analysis but which nevertheless, contribute to a characteristic property familiar to the perfumer and typify the product rather than being just an attribute.

Having assured ourselves first of a rigid scheme of manufacture, we established uniformity and quality of products by a most exacting system of quality control, based not only on the use of instrumentation (vapor phase chromatography, infrared, ultraviolet) but on subjective evaluation. By submitting a group of volunteers to a series of odor perception tests, we established a panel of individuals whose sensitivities to odor differences were far above average. By establishing acceptable standards, we could detect and correct variations in organoleptic properties.

Introduction of such products to the trade still constituted a problem of overcoming established practices, traditions, and prejudices. However, the perfumer was now afforded products which were pure in the sense of having well-defined properties, which were free from "nuances" characteristic of the raw material source, and which were of constant character that reflected a true picture of its odor. The perfumer can then build into his formulation with greater ease the properties he desires. Often the true character of a material has been obscured by the presence of other materials.

As an example, a recent article has pointed out synthetic pure nerol, geraniol, and citronellal differ surprisingly from the materials derived from natural sources. Yet the fact that in the past they were generally used together has somewhat blurred their individuality. Nerol available from natural sources in only limited quantities has not been accepted, but the synthetic product with its delicate lily of the valley fragrance is gaining in favor. Synthetic geraniol, free of the mustiness and strawlike odor associated with the naturally derived material, has the freshness generally associated with the finer rose alcohols.

Availability of the perfume chemicals is of utmost importance. Made from turpentine, abundant throughout the world and easily obtainable from pine gum or as a byproduct of sulfate paper manufacture, the perfume chemicals are now available in unlimited quantities. Importantly, their prices remain remarkably stable and generally independent of economic and natural conditions. Political revolutions with burnt-out crop fields and run-away prices, and hurricanes, plant diseases, and insect infestations no longer affect the supply of these perfume raw materials. Thus, the perfumer can be assured of availability.

Finally, since the synthetic perfume chemicals represent in a sense new materials, they offer a challenge to the perfumer and an opportunity to apply the genius of his creativeness.

In summary, the marketing of perfumery chemicals involves not only ability to supply these materials in abundant quantities, or organoleptical acceptability, and at relatively stable prices but importantly, the reorientation of the perfumer to accept or even consider such products for his use.

Session III - Processing and Utilization

D. C. Tate, Chairman

# USDA UTILIZATION RESEARCH ON NAVAL STORES PRODUCTS

by

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Research on the utilization of naval stores products is carried out at the Naval Stores Laboratory in Olustee, Fla. This work is divided into three parts: Pine Gum Investigations, Rosin Investigations, and Turpentine Investigations. We have 15 professional grade men at Olustee; most of these are organic chemists. Of course, we also have assistance and guidance from our New Orleans headquarters, the Southern Utilization Research and Development Division, of which we are a part.

One disadvantage of many research organizations, especially the smaller research organizations, is that they are limited in what they can do and the research program has to be tailored to some extent to fit the organization. We are fortunate in this respect in that we have funds with which we can contract out research problems when we do not have adequately trained personnel at Olustee for the particular problem. There are many fine university laboratories and research institutes that are available for research contracts, so we are able to consider the best laboratory to carry out a piece of work before it is undertaken.

In spite of the enormous increase in research activities in almost all phases of science, there are probably fewer people engaged in research on naval stores today than there were 30 years ago. At one time rosin was the cheapest organic acid available in any appreciable quantity, and any consumer who could see any possibility of using rosin in his product was glad to carry out the necessary research to find out how to take advantage of this low-cost material. The potential consumer was willing to do all of his own research and to devise every means he could, to use all the rosin possible in whatever formulation he had. All of the oldtime varnish makers spent a good portion of their time devising better ways of using rosin in their products.

The enormous amount of research carried out by the organic chemicals industry has developed many new competitive materials and many new processes for preparing older chemicals at much lower cost, so that today we have many materials that are competitive with rosin, several of which are selling at a lower price than rosin. Now, instead of rosin being consumed on the basis that it is the cheapest raw material available, it must compete as a quality material. Today, a potential consumer of rosin instead of being willing to carry out his own research to adapt his process to rosin, must be persuaded to use rosin on the basis of its merits. Instead of doing his own research to find this out, he must be shown that rosin will do a better job than anything else he can get at the same price. Rosin and its derivatives were used at one time as extenders, that is, as a means for lowering the prices of several more-expensive materials. Today, many of these products in which rosin was used as extenders are now cheaper than the rosin or the rosin derivatives used to extend it.

One of the best approaches for the development of new products from pine gum seems to be that based on the unique chemistry of turpentine and rosin. Instead of the trial and error method that was common 30 years ago, we are beginning to acquire enough knowledge of the chemistry of naval stores so that new uses can be developed on this basis. Wherever we can take advantage of the unusual chemistry of these products, we have the opportunity of developing new products that are not readily duplicated from other sources.

In the past few years at Olustee we have isolated and characterized three new compounds that account for 25 to 30 percent of gum rosin. The molecular structure of two of these products is radically different from any components previously known to be present in pine gum or rosin.

It is only by knowing the composition of what we are working with that we can take full advantage of its chemistry to develop new products from it.

We have recently developed rosin derivatives that give high-quality polyester resins with good fiber wettability, high tensile strength and elongation, and excellent resistance to water, alkali, and solvents. The market for polyester resins is expanding and the improvements obtained by the use of rosin derivatives in this way should provide another outlet for naval stores products.

One of the recent items developed on the basis of the chemical structure of these products is the photooxidized pine gum. This high-molecular weight peroxide should be obtainable from pine gum at a very attractive price. This product is still in the laboratory stage; it requires a considerable amount of additional work to get it ready for commercialization. It is a completely new product made from the whole pine gum and it does have many interesting possibilities. We have prepared a new product bulletin[1] on this material that is available for distribution. This bulletin gives a summary of the information that we have obtained on these new peroxides thus far. Several other papers are also available describing additional naval stores derivatives developed at Olustee, and the next speakers will give you information on other naval stores derivatives that we have developed, or are in the process of developing.

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[1] Schuller, W. H., Lawrence, R. V., Mazzeno, L. W., Jr., and Soniat, M. B., U.S. Dept. Agr. ARS 72–36, 3 pages (1965)

# ADVANCES IN USDA UTILIZATION RESEARCH ON TURPENTINE

by

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Since there is a wide variation in the chemical background of the group here today, I will try to keep my remarks as nontechnical as possible. I will be glad to discuss technical details of our research with any of you during one of the intermissions.

As most of you know, turpentine is not a single chemical, but a mixture. The two major components, $\alpha$- and $\beta$-pinene, make up 90 percent or more of most gum, wood, or refined sulfate turpentines. These two materials are very much alike but they are just enough different chemically to make it difficult to use the mixture as a chemical raw material. In many chemical reactions the two pinenes yield different products; for example, on simple thermal cracking or pyrolysis $\beta$-pinene yields mycrene which is used in considerable quantities in making synthetic odors and flavors, but $\alpha$-pinene yields alloocimene, which to the best of my knowledge has no substantial commercial use. With the proper type of catalyst both pinenes will polymerize to give resins but the products are different both chemically and physically, with those from $\beta$-pinene being the more useful. Even when the two give the same product in a given reaction--such as hydration to give synthetic pine oil--the optimum conditions will usually be different for $\alpha$-pinene than for $\beta$-pinene; so for efficient chemical utilization it will usually be necessary to separate turpentine into $\alpha$- and $\beta$-pinene.

Hence, the problem of utilization of turpentine is really two problems--utilization of $\alpha$-pinene and utilization of $\beta$-pinene. Considering the total domestic turpentine production, there is less than one-third as much β-pinene as α-pinene available. Furthermore, demand for β-pinene is now strong and this minor product is bearing the whole cost of fractionating the turpentine. In view of this situation, most of our efforts have been devoted to the problem of utilization of α-pinene, and my talk will stress this work.

Before discussing the approaches we have taken to this problem, I would like to digress for a moment and discuss some advances in analytical methods which have greatly facilitated all our research on utilization of turpentine. Since β-pinene is the most valuable portion of turpentine, knowledge of the factors which affect the β-pinene content of turpentine and methods of determining this content are important to both producers and consumers. When I entered naval stores research 15 years ago, it took about 1 gallon of turpentine and at least 1 week's work to get a somewhat uncertain analysis for β-pinene content. Today, we can get as good analysis in a few minutes, and a much better one in less than one-half hour, using less than a drop of turpentine. The analytical instruments which we use were developed by others but their most effective application to the analysis of turpentine has required research.

With these methods it has been practical to determine the composition of turpentine from individual pine trees and show that not all trees of even the same known parentage produce the same proportions of α- and β-pinene. Furthermore, various parts of the tree may produce turpentine of different composition. In some species, trees growing in one area produce turpentine which is different from that produced by the same species in another region. As a sidelight, turpentine composition seems to be a factor in insect susceptibility or resistance of individual trees. In the case of commercial gum turpentine, the α- and β-pinene ratio is fairly constant because only two species of trees are involved and especially because turpentine from so many trees is combined to make up a tank car. During the next year, we hope to get the cooperation of the industry in determining just how constant the composition is from plant to plant and from a given plant during the course of the season. Preliminary data obtained this season from tank car shipments indicate that the β-pinene content of the turpentine from a given plant is constant. Plant to plant variation is about the same as that observed in an earlier study based on turpentine from a single charge at each plant. It is our understanding that sulfate turpentine is more variable in β-pinene content, but we have not checked this.

Although the work on composition of turpentine from individual trees suggests that slash pine trees which would produce as much β- as α-pinene could be selected or bred, selection is not practical on a commercial scale and breeding requires a very long time. So, for the forseeable future we are stuck with the problem of finding uses for at least twice as much α- as β-pinene. One of the most intriguing approaches is simply to convert the α-pinene to β-pinene. This can be done but so far the processes are so complicated or give such low yields that they are not practical.

Alpha-pinene, as well as whole turpentine, is a good solvent--in general, better than mineral spirits but poorer than the better napthas--but over the years there has been a gradual decrease in this use. It is doubtful whether any amount of research could significantly reverse this trend. In contrast the use of α-pinene as a chemical has increased, and we believe that research can contribute significantly to further increases in this type of use.

Chemical uses may be as simple as the treatment of α-pinene with acid to give a crude synthetic pine oil for use in ore flotation, or as elaborate as the conversion of β-pinene to 1-menthol for use in cigarettes, which requires about one-half dozen reactions and several fractional distillations. From the chemical standpoint, the major problem in developing new uses for α-pinene is the fact that it does not contain a very useful functional group; therefore, much of our research is devoted to trying to find practical ways of introducing functional groups in the molecule. Functional groups are so important because they are, in effect, the nuts and bolts chemists use to fasten two smaller molecules together to make a new molecule. The more useful functional groups include the acid group, COOH, the alcohol group, OH, and the amine group, $NH_2$. Actually, the double bond, and the hydrogen atoms on the adjacent carbon atoms in α-pinene are functional groups, in the sense that they will react with other chemicals, and these are the portions of the $\alpha$-pinene molecule which are available for introduction of more reactive functional groups.

The reactivity of $\alpha$-pinene can also be increased by simply rearranging the carbon and hydrogen atoms without adding anything new. This is known as isomerization and is accomplished either by use of small amounts of an acid or by heating it very hot. With acids a number of isomers are obtained, but, if the isomerization is carried to completion the major isomer is called $\alpha$-terpinene. Heating or pyrolysis yields dipentene and alloocimene. All these isomerization products contain two or more double bonds and hence more reactive centers than the $\alpha$-pinene. When appropriate, these more reactive terpenes are also used as starting materials in our attempts to make alcohols, acids, amines, and so forth from $\alpha$-pinene.

Our research program is carried out in two ways--either by our own staff at the Naval Stores Laboratory, or by contract with other groups. Contract research enables us to take advantage, on a short-term basis, of skills, equipment, and personnel which are not available within the laboratory.

Those of you who have attended past Naval Stores Work Conferences have heard us talk about pinonic acid. For the benefit of those who have not, this product is made by oxidizing $\alpha$-pinene with ozone and contains two functional groups--an acid group and a ketone group. We still feel that this is a most promising product, even though the commercial production which we anticipated 2 years ago failed to develop. We are continuing to make new products from it and to encourage others to do so. These products include a dialcohol whose esters are very stable to heat. This property is of great importance in jet engine lubricants and other high temperature lubricant applications. A number of compounds have been made from pinonic acid by Dr. Hedrick's group and tested by C.S. Marvel, University of Arizona, under contract, for production of plastics, rubbers or other polymers. One of these, called vinyl pinolate, was found to react with vinyl chloride, which is a low cost commercially available material, to give a group of polyalcohols from which Dr. Hedrick's group has made polyether foam, a modern insulating material.

Ethylene and propylene, 2 low cost petroleum byproducts, will react to give a rubber which has desirable properties but requires special high priced vulcanizing agents. Dr. Marvel's group has found that an $\alpha$-pinene derivative, made by adding hydrogen to $\alpha$-pinene (or to whole turpentine) and pyrolyzing the resulting pinane, can be added to this rubber to give a vulcanizable rubber, referred to as EPT. Lest there be any misunderstanding, this pinene derivative is not the only third component that can be used, but it is hoped that it will have advantages which will enable it to be competitive with the others.

Recently we awarded a contract to U.S. Industrial Chemical Co. to use special equipment and techniques which they have to investigate the copolymerization of ethylene with $\alpha$-pinene and other related terpenes under different conditions than those used by Dr. Marvel. No results of this work are available yet; but, if successful, it will give new terpene-containing plastics for evaluation. In our own laboratories, Mr. Lawrence's group has added fumaric acid or maleic anhydride to turpentine to get acids from which very light colored polyester resins have been obtained. Such products are useful in fiberglassing of boats, and so forth. These particular products have certain deficiencies, however, and my own group has under way a comprehensive study of the reaction of $\alpha$-pinene and derived terpenes with maleic anhydride and other so-called dienophiles which we hope will provide a basis for improving them.

As part of this same project, $\alpha$-terpinene has been reacted with a variety of low-cost dienophiles to introduce acid groups, nitrile groups, and aldehyde groups. Further conversion of these primary products gives amines, alcohols, and amides. These products are being evaluated and will be compared with similar products made directly from $\alpha$-pinene.

The least expensive chemical that can be added to $\alpha$-pinene to introduce a functional group is air. Our own research and that of others has shown that the hydroperoxide which this reaction forms is a mixture and is not very stable; so good yields of any one product are hard to obtain. However, we found, some years ago, that if the pinene was first hydrogenated to pinane the reaction with air or oxygen could be controlled to give excellent yields of a substantially pure hydroperoxide. This product was found to be a very good catalyst for making the type of synthetic rubber used in automobile tires, as was a similar hydroperoxide which we made from hydrogenated dipentene. The latter product, paramenthane hydroperoxide is now the principal catalyst used for synthetic rubber production. Additional research by ourselves and others, and pilot plant production by at least one company failed to develop a market for pinane hydroperoxide in spite of its potential low cost. Within the past year, however, we have received reports that it is being made and offered for sale in Germany. A related development is the report in a German patent and publication that the tertiary alcohol made by reduction of the hydroperoxide can be pyrolyzed to linalool, which is widely used in the perfume, cosmetic soap, and flavor industries.

Good yields of a single hydroperoxide and the corresponding alcohol can be obtained using air and $\alpha$-pinene provided a catalyst and lots of light are used. The catalyst and light add to the cost of the process, and the alcohol is a rather unstable secondary one. Alcohols are very useful chemical intermediates, that is chemicals from which other chemicals are made; however, the most important uses require, or greatly favor alcohol groups on the end of the molecule (primary) rather than elsewhere in the molecule. Hence the secondary and tertiary alcohols, which can most readily be made from $\alpha$-pinene are not the most desirable ones. A few years ago, John Braun of our staff and H. C. Brown of Purdue University both discovered that a primary alcohol, myrtanol, could be made from $\alpha$-pinene but the process required a very expensive reactant. At present Dr. Brown has a contract to see whether he can reduce the cost of the process. Incidentally, this contract also covers work on fatty acids.

Two other known routes from petroleum hydrocarbons to alcohols are being applied to terpenes under contract. Dr. Milton Orchin at the University of Cincinnati is investigating the addition of carbon monoxide, and A. T. Blomquist at Cornell University is investigating the addition of formaldehyde. Alpha-pinene and terpenes that can be obtained from it are being stressed, and special efforts are being made to add two alcohol groups and get a diol. Thus far neither group has found a way to get outstanding yields of a single alcohol, but they have made a number of primary alcohols and are now working on improvement of the yields. I should perhaps mention, for the benefit of you who are not chemists, that the university professors in charge of these various research contracts are all internationally known experts in the reactions they are studying for us.

Dr. Hedrick's group has made a very interesting primary alcohol from $\alpha$-pinene by starting with $\alpha$-pinene epoxide which is, or has been, commercially available. It can be rearranged and then reduced to give a primary alcohol which still contains a double bond. Related acids, aldehydes and amines can also be made. Applications for these new products are being sought in various types of polymers.

In general, larger molecules are worth more than smaller ones. Hence, we have recently awarded a contract to George Butler here at the University of Florida to find the best way to fasten two $\alpha$-pinene molecules together to make dimers and then to characterize the products and find out what other chemicals can be made from them. This project has gotten off to a good start but it is much too early to discuss the results.

In summary, then, the major problem in increasing utilization of turpentine lies in finding more uses for $\alpha$-pinene. The lack of reactive functional groups in the $\alpha$-pinene molecule makes this task more difficult. Progress has been made in finding ways to add several kinds of functional groups to the terpene molecule, and a diversified research program to improve known processes, develop new ones, and evaluate the products is under way. However, much more research, both basic and applied, by industry, universities, and government, is needed to assure continued efficient, and profitable utilization of turpentine.

# RECENT RESEARCH ON PINE GUM AND ROSIN AT THE NAVAL STORES LABORATORY

by

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Chemical utilization research on pine gum and rosin at the Naval Stores Laboratory, as in the past, consists of studies to determine the composition of pine gum and rosin and the resin acids contained therein and to develop new uses for rosin and the resin acids.

Commercial rosin--gum, wood, and tall oil--is a mixture of materials, and consequently the properties of rosin and uses for it are a result of the cumulative effects of each of the materials present. Over the past several years, considerable effort has been made to delineate composition and to establish differences between the three kinds of rosin. Results of research of this kind are essential for quality control of the product and for predicting usefulness in assorted applications.

Present day research on composition has been aided tremendously by the development of new analytical equipment and the new techniques which have made possible the separation and identification of components of rosin. Separation techniques resulted in isolation of pure components from the mixture. These pure materials then were used to standardize highly specialized assorted electronic equipment. To illustrate: Assume Product A is a component in most rosins. When pure A is subjected to the conditions of this specialized equipment, certain responses are obtained. To determine if Product A is in rosin, all that is required is to subject rosin to the conditions used for pure A and see if a response is obtained identical to that of the pure substance. This can be repeated then for other pure substances B, C, D, and so forth. When all the components of rosin are thus identified, analysis of a rosin sample may become quite simple. In practice, highly specialized technicians and technical people are required to keep the equipment in working order and to interpret the results. The art at this time is highly developed. Only a few minutes are required for routine analyses indicating the composition of the rosin. Eighty to ninety percent of the components of rosin are known--the unknown 10 to 20 percent is made up of minor amounts of a rather large number of substances.

To be more specific, rosin is composed of a number of materials called resin acids. These differ only slightly one from the other but this difference is sufficient to account in part for crystallinity and many of the other properties. Rosins differ also in the composition of the nonacidic components. These also have an effect on the properties of the rosins.

Personnel at the Naval Stores Laboratory continue to work on composition of slash and longleaf pine gum, gum rosin, wood rosin, and tall oil rosin. In the last 5 or 6 years, two new resin acids and a couple of nonacidic components have been found, characterized , and reported.

After determining the composition of rosin, the question arises as to the behavior of the component parts of rosin to various treatments. This can be illustrated by the following: Rosin is always processed by heating. What effect then does heat have on Compounds A, B, C, and so forth, that appear in rosin and does the cumulative effect of heat on each material add up to the normal changes one sees when rosin is processed? Heat is only one variable that may produce change. Others are air (oxygen), acid, light, time, and so forth.

Some of these process variables have been investigated. To work out all the conditions is a never ending task. Some accomplishments in this area should be noted. Pine gum as it comes from the tree contains substantial quantities of levopimaric acid. This is totally absent in processed rosin. Further investigation has shown that this acid is not stable to heat or acid and is converted to other acids during processing of the gum. These studies were highly significant. They explained the disappearance of levopimaric acid and did much to elucidate the composition of gum rosin. This observation was important, but recognition by the consuming industry that care must be exercised in handling rosin was probably even more important.

Much is known about the composition of rosin. There is quite a lot more to learn about the chemistry of rosin. In other words, what effect does this treatment have on the rosin. Some progress has been made in the understanding of the chemistry of the pure resin acids. We need to know more. Knowledge of this sort is dependent on availability of pure substances for investigation. Five years ago only very small amounts of materials were obtainable and these were acquired with difficulty. Today, we have processes for isolation of several of the components of rosin, some of them in sizable amounts. The knowledge of the chemistry of these is being developed.

In summary of the work on composition, many of the differences in composition of the three types of rosin have been determined and are well known. In determining composition, methods were developed for isolation of pure components from rosin. With improved methods of isolation materials have been obtained in quantity and used for chemical studies. These studies have resulted in new, useful reactivity information.

In addition to work on composition and allied studies referred to above, personnel at the Naval Stores Laboratory have been concerned with research to find new uses for pine gum and rosin. In simple terms, to accomplish this ways have been sought to (1) modify rosin per se by relatively simple treatments and (2) to convert pine gum and rosin or components of these to chemicals which can be used as intermediates in the chemical industry. The consuming industry has made extensive searches for simple ways to modify rosin. These include heat treatment, bleaching, extraction, distillation, steam sparging, disproportionation, reduction and so forth. There really are not many simple unexplored ways that can be used to modify rosin. A more or less recent development of this type used by industry is formaldehyde modified rosin. The amount of formaldehyde used varies widely depending upon the changes desired in the rosin. Minor amounts have been used to decrease the crystallizing tendencies of the rosin. Addition of larger amounts in conjunction with other materials (fats, fatty acids, and acetic acid) give rosin-based varnishes and metal resinates for printing inks. For a number of years rosin has been reduced to convert the acid function to an alcohol. Reduction of formaldehyde modified rosin similarly converts the rosin to an alcohol having somewhat different properties.

Most of you are familiar with the term "maleic modified rosin" which is made by heating rosin with maleic acid anhydride. One of the end uses for a product of this sort is in paper size. This is a widely used application. Modifications of this type reaction have been under investigation for some time at this laboratory. Much new information on the reaction and reaction products has been reported. One of the most practical is reaction of rosin with acrylic acid and use of this reaction product to form polyester type resins. Most of you have knowledge of resins of this type. At least one industrial concern has modified rosins for use in polyester resins. The modification is different yet similar to that referred to above.

It was found that a good paper size can be made by distillation of turpentine from neutralized pine gum. The status of this development not yet used by industry is about the same as it was when reported to this group 2 years ago.

Pine gum is a rather cheap raw material from which chemicals might be obtained. One of the most unusual things about gum is that it contains levopimaric acid. This acid cannot be obtained from any other source. We have a process for isolating this acid from gum. The process is quite simple and levo has been made available in 10- to 20-pound quantities in our pilot plant at Olustee. The acid can be removed from the gum and the gum reconstituted to give turpentine and rosin. The cost of the acid will depend upon the efficiency of the process used in its isolation. Associated with efficiency are type of process, continuous or batch, and size of plant. The raw material cost of the acid is that of gum, today about 7 cents a pound.

Materials processing costs could be as little as 1 to 2 cents.

Commercial isolation of levopimaric acid could be developed by industry. The question is "what can it be used for?". A market must be developed for it. It reacts with maleic and fumaric acids to produce commercial materials. Uses of those products and similar materials could be expanded and used for new resins. The levopimaric acid has been used in synthesis of drugs (hormones). Now the economics are unfavorable for preparation of hormones from rosin. Perhaps commercial availability of "levo" at low cost might change the economic picture. It reacts with oxygen to produce a material which can be converted to other interesting chemicals. Some of these are useful in polymers. It reacts with formaldehyde, giving a material that looks very useful. Although considerable effort has been expended in studying the chemistry of this acid, much remains to be done. The possibilities of new research and of obtaining new products are exciting. It is quite possible that some day pine gum may be produced to supply this acid.

Pine gum has been reacted with oxygen in a similar manner to that used for levopimaric acid. The reaction product is cheap and contains active oxygen which suggests a number of uses most of them being related to polymer applications.

The trend in research on rosin is to prepare pure chemicals from rosin and to modify rosin in such a way as to increase the functionality. Rosin contains only one reactive functional group. The introduction of other groups such as hydroxyl, amino and isocyanate, would be achieved more readily from pure chemicals and should result in increased uses. More efficient methods for separating pure chemicals from both gum and rosin are needed. As stated earlier, there is some chance of success in producing levo from gum. Rosin appears to be a less attractive raw material. It should be noted that rosin (all three types) contains 60 percent of resin acid which can be converted to abietic acid. No one has come close to finding a use for abietic acid. On the other hand, it is the opinion of this author that it should be possible to convert, quantitatively, all the abietic type acids to dehydroabietic acid, which could be made polyfunctional much more easily than other resin acids. If this can be accomplished, the total dehydroabietic acid in some rosins would be as high as 70 percent. There are a few unsolved problems here. We do not know the answer but I personally think there is a solution.

I shall be happy to answer any questions the group may have. If your question is technical, perhaps it will be better to have a private discussion. In any case, it has been a pleasure talking to you.

# NEW PRODUCTS FOR INDUSTRY FROM USDA RESEARCH

by

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Initial outlets for oleoresin (pine gum produced commercially entirely by turpentining) in Naval Stores applications were for simple needs, with virtually no concern for the quality of the gum, the complexity of its chemical composition, or the productivity of the tree. The operations for its production, including eventually the separation of the rosin from turpentine, were crude, hazardous and scattered throughout the woodlands of the Southeastern and New England States.

The earliest date on record for the production of naval stores in what is now the continental United States is 1528. The occasion was the production of pitch or tar used in the construction of five crude boats on the shores of Apalachicola Bay, on the Gulf Coast of Florida.

Instructions and specifications for the production of oleoresin for shipment to Europe were clearly set forth by the Colonists as follows:

Instructions for Suche Things
As are to be Sente From Virginia
(1610)

"Pyne trees, or ffirre trees are to be wounded within a yarde of the grounde or boare a hoal with an agar the third pte into the tree, and lett yt runne into anye thinge that may receyve the same, and that wch yssues owte wilbe Turpentyne worth 18 Ł Tonne."

Though not obvious by a cursory look at today's field operations, significant changes have been made over the years to increase tree productivity, to improve the quality of the gum, and to provide proper care of the tree.

With the development of new uses for rosin and turpentine derived entirely from gum, problems concerning availability, production costs, and quality became apparent. These were partly solved by the production of naval stores products from pine wood stumps. The acceptance by industry of the Olustee Gum Cleaning Process, now being practiced by 20 plants, resulted in the production of better quality materials at lower cost.

Production of naval stores products by the pulp-paper industry greatly affected the sales of the materials obtained from gum and pine stumps. Chemicals obtained from petroleum which meet more exacting performance specifications or are available at lower cost have also entered into this competition. In response to the changing economic and technological developments the research activities at the Olustee Station were redirected to meet the challenge.

To capitalize on the unique chemicals contained in pine gum, basic research was conducted on its composition and the fundamental properties of the individual compounds isolated from oleoresin. In cooperation with industry many of Olustee's research results have been translated to profitable productive operations. The developments range from the steam cleaning of dip-barrels to more economical and less hazardous separation of high quality rosin from the gum, a better understanding of rosin chemistry, improved methods for the separation of alpha- and beta-pinene as well as the preparation of new chemicals from rosin acids, and from turpentine. They also include in some instances uses for the products.

Examples of new products and improved processes that have been commercialized as a result of the joint effort are maleopimaric acid, metal resinates, paramenthane hydroperoxide, formaldehyde modified rosin, disproportionated rosin, hydrogenated rosin, improved rosin paper size, pinane, allo-ocimene, mycrene, mycene alcohols, and many others.

It is virtually impossible to ascribe a precise dollar value to these developments at the ingate or the consumer levels. Conservative estimates of annual savings to industry have been placed by some at $1 million, and sales created by the production of new products exceed $6 million a year.

Research studies at the Olustee station continue to provide industry with new technical information that offers still further opportunities for increased naval stores sales. Processes for the production of levopimaric acid--present in significant quantities only in gum rosin--and rosin acid peroxides have been developed and are ready for commercialization. Both products can be easily prepared by simple operations in essentially standard equipment from readily available chemicals. Their production may well offset the loss of gum rosin sales to soap producers and manufacturers of surface coatings, and the threat by competitive products to continued volume sales of rosin for paper-size applications.

A new product obtained by the oxidation of oleoresin under specific conditions is essentially a mixture of three gum acid peroxides with an active oxygen content of approximately 3 percent (figure 1).

It is an off-white solid with a melting range of 61° to 73° C. soluble in acetone, benzene, ether and alcohols. Its stability to shock and storage are strong plus factors in recommending its use as a catalyst.

Physical properties:

| | |
|---|---|
| Appearance: | Free-flowing, off-white solid |
| Molecular Weight: | 318 (approximate) |

| | |
|---|---|
| Softening Point: | 60°-73° C. |
| Solvents: | Alcohols, acetone, benzene, and ether |

Chemical properties:

Stable to shock

Stable on prolonged storage at room temperature.

Can be converted to diepoxide

Sensitive to strong acids and bases.

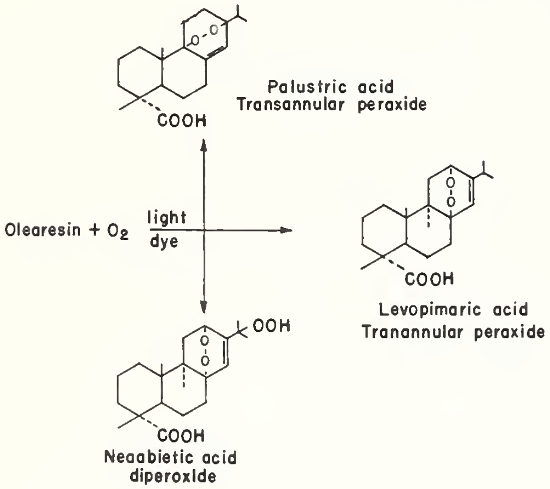

Figure 1.--Structure of pine gum peroxides obtained by oxidation of oleoresin.

The peroxide mixture is prepared by air oxidation of a 15 percent methanol solution of pine gum in the presence of light as shown in the flow diagram of figure 2. Following aeration, the solution is treated with Norit A, filtered, and stripped under vacuum to remove the menthanol and turpentine.

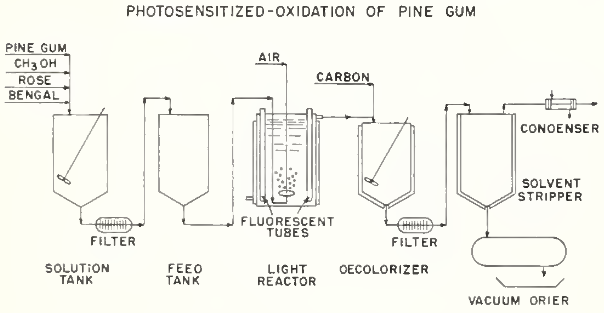

Figure 2.--Flow diagram showing preparation of pine gum peroxides.

Processing equipment constructed of carbon steel may be used for the production of pine gum peroxides. The process is readily adaptable to continuous operation. Reactors jacketed for cooling and equipped with fluorescent lights set in long pyrex tubes, similar to reactors being used for the continuous chlorination of organic materials, may be practical for the aeration step in the process.

Mixed rosin acid diepoxides can be prepared by refluxing a 20 percent solution of the oxidized gum in xylene.

Potential uses for the rosin peroxides and diepoxides are shown as follows:

Peroxides:

In plastics and rubber industries.

Initiators (or less correctly, catalysts).

Curing or vulcanizing agents.

Stabilizer for polyvinyl chloride.

Casting and laminating resins.

Polymerization of cinyl monomers.

Styrenated casting resins, gum rosin ester.

Diepoxides:

Castings and laminating resin.

Surface coatings.

Preliminary cost estimates show that the mixed rosin acid peroxides can be manufactured in moderate quantities at a cost of about 25¢ a pound. Competitive products are currently selling from 75¢ to as much as $3 a pound. Capital investment costs for the production of 2 million lb. a year may not exceed $500, 000.

Another new product, levopimaric acid, a colorless solid melting at 151° to 152° C., is soluble in alcohol, ether and benzene, and possesses the structure shown below and in figure 3.

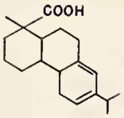

Figure 3.--Structure of levopimaric acid.

Physical properties:

| | |
|---|---|
| Appearance: | Colorless crystals. |
| Melting Point: | 151° to 152° C. |
| Solvents: | Benzene, ether, and alcohols. |

Chemical properties:

Isomerizes at 150° to 200° C. to palustric, neoabietic and abietic acids.

Gradually disproportionates in ether solution.

The acid is isolated from pine gum, virtually its only natural source, an amine salt which on treatment with an ion exchange resin, as for example Amberlite IRC 50, yields the desired product (figures 4 and 5). It is of interest to note that the removal of levopimaric acid from pine gum has no appreciable effect on the properties of the coproducts namely, turpentine and the residual rosin.

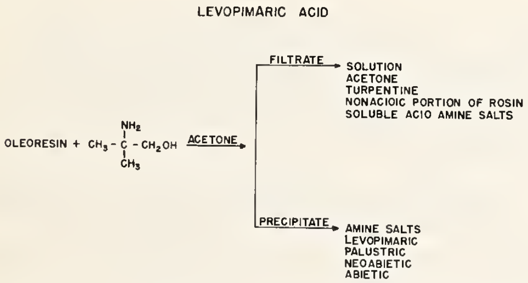

Figure 4.--Step A of procedure for the isolation of levopimaric acid.

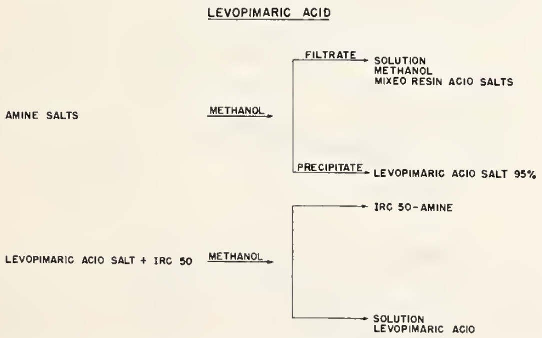

Figure 5.--Step B of procedure for the isolation of levopimaric acid.

Basic equipment required for the manufacture of the acid is shown in figures 6 and 7.

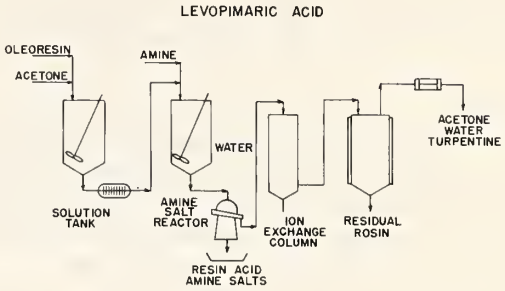

Figure 6.--Step A of flow diagram showing preparation of levopimaric acid.

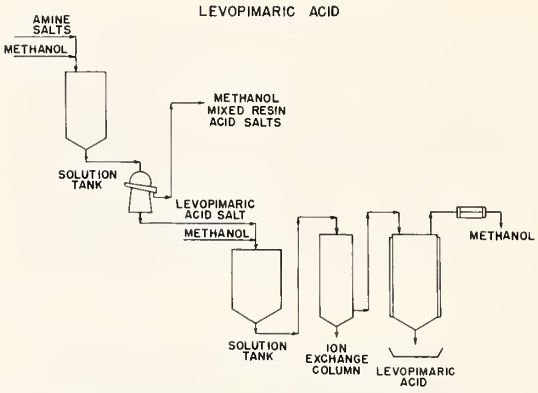

Figure 7.--Step B of flow diagram showing preparation of levopimaric acid.

Except for the ion exchange column, wherein a dilute mineral acid is used to elute the amine, mild carbon steel equipment should be suitable for the production of the acid from oleoresin.

Possible uses for levopimaric acid are shown below:

| | |
|---|---|
| Adhesives: | Reaction products with urea and formaldehyde. |
| Agricultural: | Pesticides, fungicides, plant hormones. |
| Chemical: | Synthesis of esters, amides, isocyanates. |
| Plastics: | Polymer modifier - plasticizers. |
| Textiles: | Crosslinking agent with formaldehyde. |

Based on preliminary cost estimates, it seems reasonable to assume that levopimaric acid of 95 percent purity can be manufactured at a cost of not over 40 ¢ a pound. Capital investment for producing 1 million lb. a year may amount to $350, 000.

Several recent developments warrant industry consideration as possible new outlets for turpentine. The growing demand for beta-pinene, especially its continued use in established applications such as the production of polymers, Piccolyte for example, and myrcene assures profitable markets for the isomer. This unfortunately is not the case for alpha-pinene.

Research effort has been expended, with some degree of success, on the conversion of alpha-pinene to beta-pinene. Processes for the conversion are known. However, due to the low yields obtained in the rearrangement of one isomer to the other, the economics under existing market conditions are not sufficiently attractive to interest industry in the production of beta-pinene by established technology.

Potential new outlets for alpha-pinene point toward its use in the production of pinonic and pinic acids, pinonaldehyde, diepoxides from allo-ocimene and polymeric products that are readily obtainable from pinene and its derivatives.

Pinonic acid, a versatile chemical containing two reactive functional groups, the structure of which is shown in figure 8, is a solid which melts at 105° C. It is soluble in the more common solvents such as water, alcohol, acetone, chloroform and benzene. Its physical and chemical properties are given below:

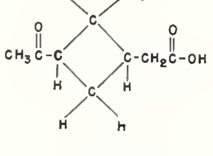

Figure 8.--Structure of pinonic acid.

Physical properties:

| | |
|---|---|
| Appearance: | White, free flowing powder. |
| Melting point: | 100 ° C. min. |
| Solvents: | Water, acetone, ether, chloroform, benzene; sparingly soluble in aliphatic solvents. |

Chemical properties:

Contains two reactive groups.

Readily forms semicarbazone.

Easily esterified.

Can be reduced to pinolic acid.

Stable under ambient conditions.

Pinonic acid can be made from alpha-pinene by ozonolysis or treatment with permanganate, as shown in figure 9.

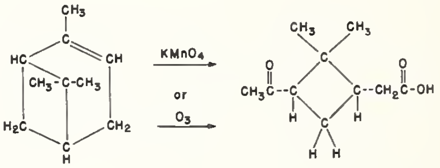

Figure 9.--Preparation of pinonic acid by either ozonolysis or treatment with permanganate.

In view of the success achieved in the application of ozonolysis to the production of organic materials, it is somewhat surprising that the production of pinonic acid has not been undertaken by this simple and inexpensive process.

Pilot plant quantities of pinonic acid have been prepared at the Olustee Station by the permanganate oxidation of alpha-pinene. The flow diagram in figure 10 indicates the principal steps involved and basic equipment requirements.

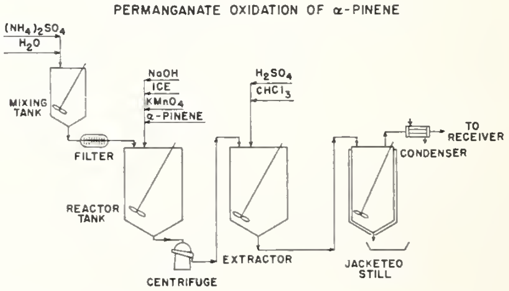

Figure 10.--Flow diagram showing preparation of pinonic acid.

Potential markets for pinonic acid are shown below:

| | |
|---|---|
| Adhesives: | Thermosetting--hot melts, etc. |
| Agricultural: | Plant hormones, pesticides, and fungicides. |
| Chemical: | Chemical intermediate--synthesis of esters, amides, amine salts, and vinyl monomers. |
| Mechanical: | Automotive--lube and oil additives, cutting oils, and greases. |
| Plastics: | Plasticizers, polyester resins, epoxy resins, and polymers. |
| Rubber: | Antioxidant--curing aid. |
| Textiles: | Mercerizing agent, catalyst, finishing agent, and formaldehyde cross-linking agent. |
| Miscellaneous: | Ingredients for paints, polishes, and ion-exchange resins. |

Estimated production costs for the ozonolysis process range from 20 to 30¢ a pound. Production costs for permanganate oxidation range from 65¢ to $1.20 a pound, depending on volume produced. Capital investment for the production of pinonic acid at an annual rate of 2 million lb. may approach $1 million.

USDA brochures describing in greater detail the preparation of pine gum peroxides, levopimaric acid, and pinonic acid are available to industrial concerns that may be interested in the manufacture of these versatile, useful, and inexpensive chemicals.

Vinyl monomers, useful in making plastics, resins, and rubbers prepared from oleoresin include vinyl levopimarate, vinyl pinonate, hydronopol acrylate, and several olefins.

Recently it has been shown by C.S. Marvel and his associates at the University of Arizona, while conducting research under contract with USDA, that a new type of rubber with unusual properties can be produced by the polymerization of a mixture consisting of ethylene, propylene, and 5, 7-dimethyl-1, 6-octadiene. The EPT rubber is reported to be highly resistant to oils and atmospheric ozone. Automotive, electrical, and appliance industries have shown an unusually active interest in the new rubber.

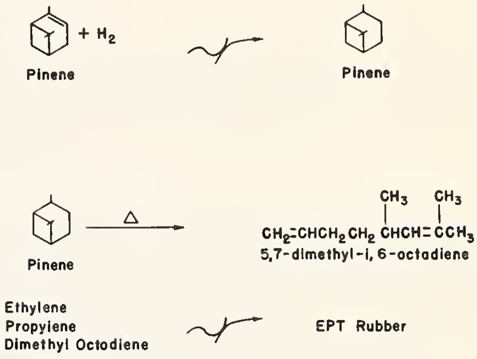

Figure 11.--Preparation of EPT rubber.

The essential ingredient for the production of EPT rubber, 5, 7-dimethyl-1-1, 6-octadiene, is obtained along with the 3, 7-dimethyl isomer by the pyrolysis of pinane. The hydrogenation of turpentine yields pinane. Synthetic terpene alcohols are made from 3, 7-dimethyl-1, 6-octadiene, the co-product of pinane pyrolysis.

The simplicity and ease with which a number of interesting terpene derivatives can be made from turpentine might best be illustrated by a recent publication which appeared in the Journal of Chemical Education. X. A. Dominguez and G. Leal of the Technological Institute of Monterrey, Mexico, have selected for predominantly student training a number of laboratory experiments requiring the use of alpha-pinene to illustrate unit operations and unit processes of organic chemistry. Unit process operations involve the addition of hydrogen chloride to double bonds, rearrangements, hydrolysis of oximes, saponifications, ozonolysis, premanaganate oxidation, nitration, nitric acid oxidation of side chains, reductions, and chromic acid oxidation.

Bornyl chloride, camphene, isobornyl acetate, camphor, para-cymene, camphoric acid, limonene, carvone oxime, carvacrol, and para-toluic acid are among some of the compounds produced by the students in becoming familiar with a sizable segment of agricultural chemistry.

Although emphasis has been placed on the preparation of the chemicals from pine gum, it is apparent to those familiar with naval stores products that many of the research results reported by Olustee scientists are indeed applicable to other areas of industrial utilization of agricultural products.

# POTENTIAL APPLICATION OF PETROCHEMICAL REACTIONS TO THE UPGRADING OF NAVAL STORES PRODUCTS

[Summary]

by

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Economic factors play an important role in the choice of petrochemical reactions for commercialization. It is particularly desirable to choose processes that have low manpower requirements and that allow continuous processing with high productivity in a minimum number of steps. On the other hand, certain reaction characteristics--which are undesirable from the point of view of laboratory synthesis, for example, low conversion per pass and low efficiency--are often tolerated.

Petrochemical reactions are often based on classical chemistry, though there are often important modifications which are imposed by economic considerations. The list of suitable reactions to choose from is much shorter than the list that the laboratory experimenter has at his disposal. One finds a greater use of catalysis and vapor-phase reactions among industrial processes, but only a few petrochemical reactions--the Oxo Reaction and Oxidative Chlorination, for example--are ones which are rarely used in laboratory-scale organic synthesis.

The principal petrochemical starting materials are the simple saturated, olefinic, and aromatic hydrocarbons costing in the range of 1.5 to 12 cents per pound. Naval stores products do not compete directly with these but rather with "second and third generation" petrochemicals that have more complicated chemistry and, therefore, more specialized uses. In some cases the naval stores product has the economic edge, but this usually does not allow direct substitution of the naval stores material for the petrochemical one. The chemical structures are practically never similar enough to permit this. In developing new chemical uses for naval stores products, one should take advantage of the special structural features and chemical behavior of these materials rather than try to make them conform to the behavior of their petrochemical analogs.

In order to operate a chemical process with low manpower, it is necessary to provide for continuous operation, and this, in turn, requires more pieces of processing equipment than are needed for carrying out the same chemical reactions batchwise, as is usually done in the laboratory. This is illustrated by a flow diagram for the hypothetical manufacture of alpha-pinene oxide.

There are good opportunities for naval stores products in the fields of specialty chemicals and biologically active chemicals, but these are difficult to discuss in general terms and must be attacked individually, often with a highly exploratory, Edisonian approach. By far the largest market is in the field of synthetic resins for plastics, elastomers, fibers, and surface coatings. Here, we know, there are certain functional groups--carboxyl, amino, isocyanato, and others--which are highly desirable and which we should strive to introduce into the naval stores materials in order to make useful products. "High functionality"--that is, a great number of such groups per molecule--is desirable.

Several approaches to the chemical modification of naval stores materials were discussed, emphasis being placed on the utilization of alpha-pinene, beta-pinene, dipentene, and the rosin acids. Some proposed chemical transformations are illustrated in the following listings and in 10 figures.

### Characteristics of petrochemical reactions:

Low overall cost.

Low-cost reactants.

Long-lived or regenerable catalysts.

High reaction rates.

Low manpower requirements.

Continuous processing.

Minimum number of steps.

Conversion may be low.

Efficiency may be low if reactants are cheap.

Coproducts acceptable if they have ready markets.

### Classification of petrochemical reactions:

1. Old well-known reactions.
2. Adaptations of well-known reactions.
3. Reactions rarely used except for petrochemical manufacture.

### Petrochemical starting materials:

| | Cost per lb. (cents) |
|---|---|
| Saturated hydrocarbons | 1.5 to 5.0 |
| Olefins | 2.0 to 10.0 |
| Aromatics | 4.0 to 12.0 |
| Ethylene | [1/]4.0 |
| Propylene | [1/]3.0 |
| Butadiene | [1/]10.0 |
| Benzene | [1/]4.0 |
| Toluene | [1/]4.0 |

[1/] Approximate.

### Guidelines for producing commerical chemicals from naval stores products:

Utilize low-cost reactants.

Avoid large numbers of steps.

Keep number of solvents and processing chemicals to a minimum.

Keep investment low.

Make use of structural features of the molecules.

Avoid direct competition with close petro-chemical analogs.

### Classification of petrochemical products:

Solvents[1/]

Plastics[1/]

Elastomers[1/]

Fibers[1/]

Surface coatings[1/]

Surface active agents

Functional fluids

Biologically active chemicals

Specialty chemicals

[1/] Monomers.

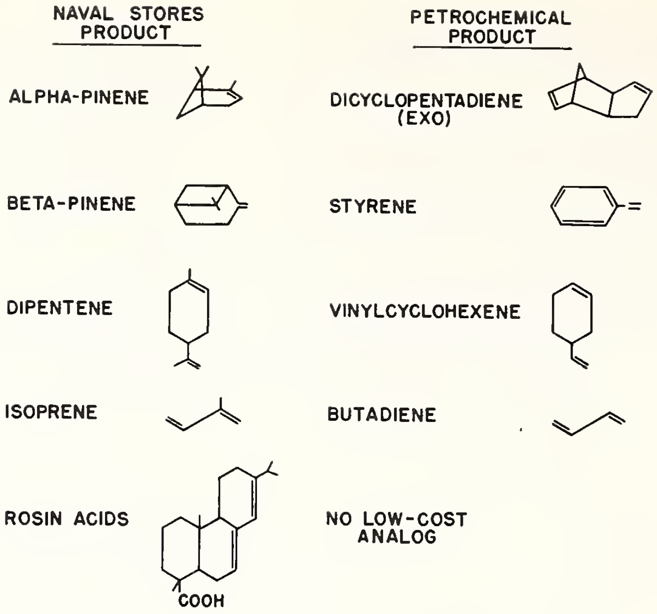

Figure 1.--Structure similarity.

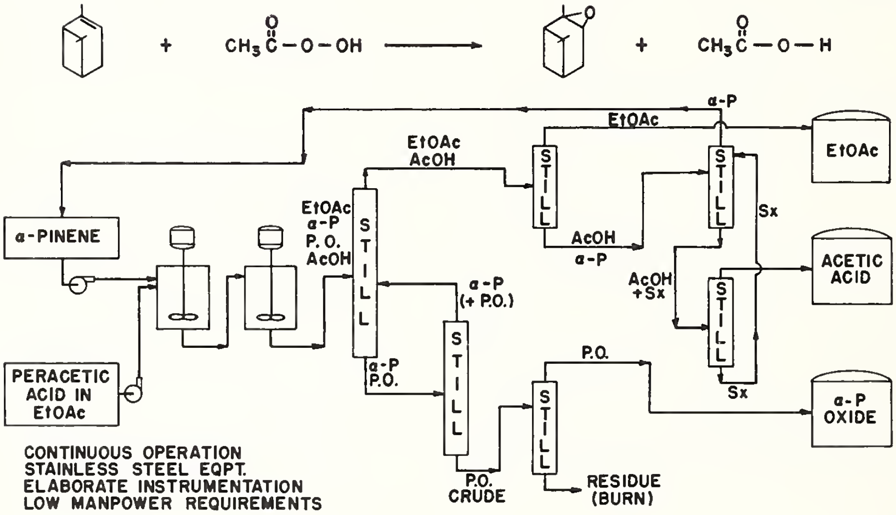

Figure 2.--An illustration of a potential commercial process for the production of α-pinene oxide.

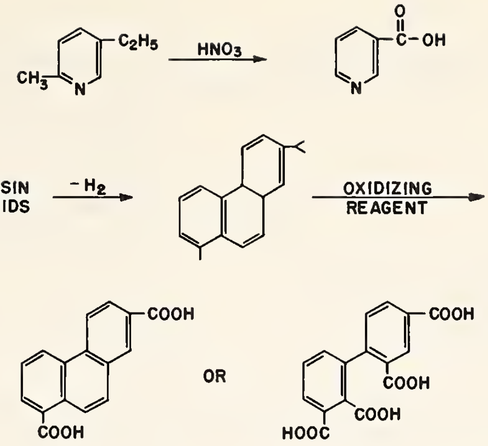

Figure 3.--Use of severe oxidizing conditions

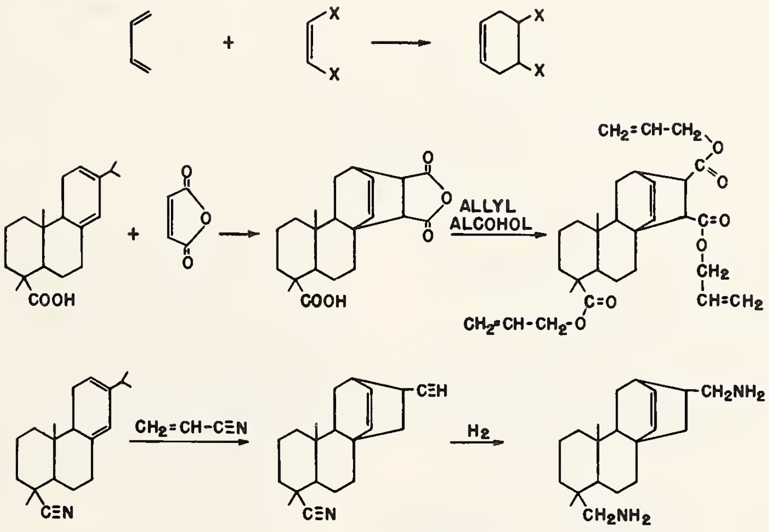

Figure 4.--The Diels-Alder reaction

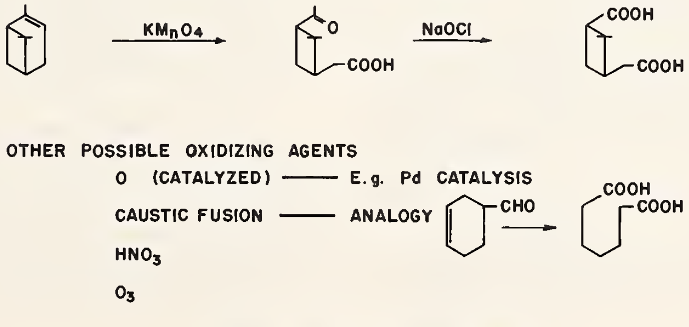
KMnO₄
O
COOH
NaOCl
COOH
COOH
OTHER POSSIBLE OXIDIZING AGENTS
O (CATALYZED) —— E.g. Pd CATALYSIS
CAUSTIC FUSION —— ANALOGY
CHO
COOH
COOH
HNO₃
O₃

Figure 5.--Pinic and norpinic acids.

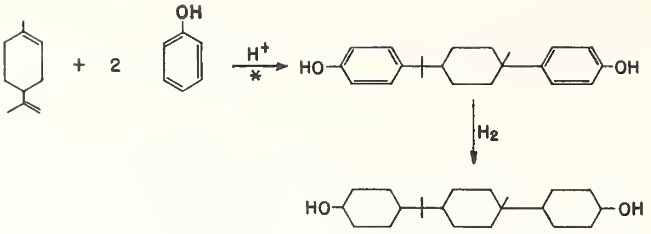

Figure 6.--Condensation reactions 1/

1/ Zinke, Horel, Benndorf, Dreweny, and Ziegler J. Prakt Chem. 156: 97–102 (1940)

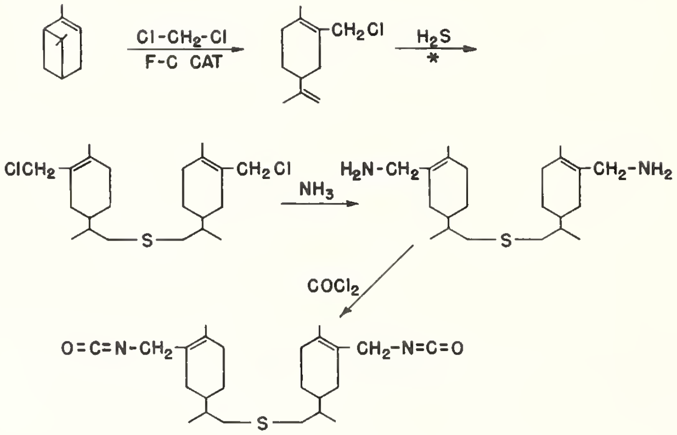

Figure 7.--Linking of terpene molecules 1/

1/ Prilezhaeva, E.N., and Shostakovskii, M.F., Russian Chemical Reviews 32:399–426 (1963) (English edition pagination)

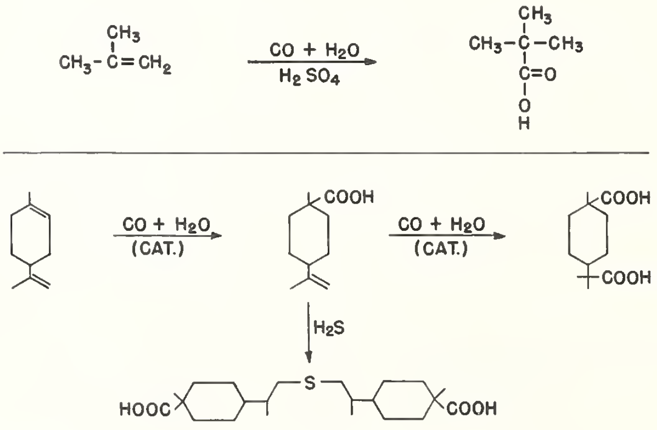

Figure 8.--The Koch reaction

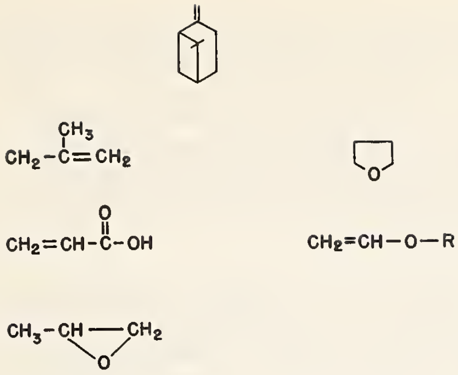

Figure 9.--Potential copolymerization

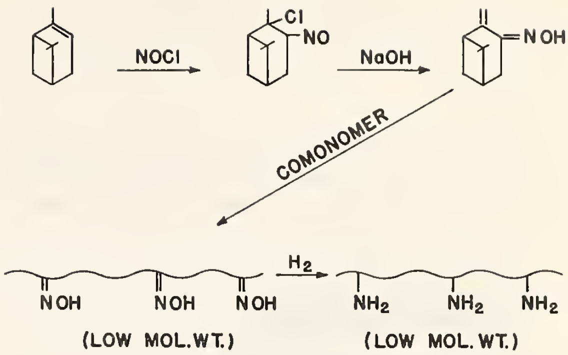

Figure 10.--Copolymerization of pinene derivatives.

# NAVAL STORES IN THE RUBBER-BASED ADHESIVES INDUSTRY

by

H. P. Weymann
Heyden Newport Chemical Corp.
Pensacola, Fla.

The role of pine pitch as an adhesive in the sailing ships of yesteryear is too well known to dwell upon here. Indeed, it is probable that the exudation of pine trees was used by prehistoric man as one of the first glues. The pressure-sensitive adhesive industry, based on a marriage of naval stores and natural rubber, had its inception midway through the last century when surgical tape was invented.

Today, resins derived from turpentine are widely used in rubber-based pressure-sensitive adhesives, with some minor use in rubber-based caulking compounds and mastics. This discussion, therefore, will be restricted to that class of adhesives characterized as "pressure-sensitive."

A pressure-sensitive adhesive is one which is permanently tacky, which requires no activation by heat, solvent, or moisture, and which will adhere strongly to most surfaces upon application with a minimum of pressure. By far the greatest use of this class of adhesives is in the form of tape, where the adhesive is supplied as a coating on one side of a flexible strip of paper, plastic, or cloth. The most familiar of the more than 200 types of pressure-sensitive tapes now on the market are the surgical and the cellophane tapes. Among the more specialized classes of industrial tapes are the very narrow, colored plastic tapes which can replace inked lines in complex architectural drawings, tapes which are soluble or dispersible in water for use in paper mills, and fiber-reinforced tapes with tensile strengths up to 500 lb. per inch width. It can be seen that the versatility of tape design has been a major factor in the growth of this industry. The industrial use of tape started less than 40 years ago when the need for masking tape was recognized by the automobile industry. Since then, industrial, pressure-sensitive tape has grown to approximately $250 million annual sales.

The naval stores industry, with its many derivatives of rosin and turpentine, has played a major part in this growth, and in the wide acceptance of tape as a part of today's life. From the start, naval stores have been regarded as the primary source of tackifying resins for rubber-based adhesives.

Figure 1 illustrates the construction of a typical pressure-sensitive tape. The thickness of the adhesive coating may vary from less than half-of-one-thousandth of an inch to as much as five-thousandth of an inch. Thinner adhesive coatings are used for labels and other applications involving only flat surfaces, while heavier coatings are required for cloth tapes used on irregular surfaces. A primer or tie-coat is required to insure that the adhesive will remain anchored to the backing, and will remove cleanly from a surface. The thickness of the prime coat normally does not exceed one ten-thousandth of an inch. The backing may be almost any flexible material capable of being wound on itself in roll form. The release coat is composed of a material to which the adhesive has only a slight bonding tendency and is required to facilitate unwinding of the roll of tape.

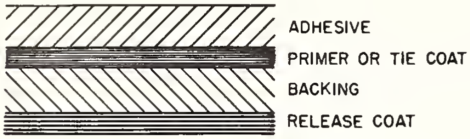

Figure 1.--Construction of typical pressure-sensitive tape.

The performance of a pressure-sensitive tape depends primarily on three major factors: Tack, adhesion, and cohesion. Figure 2 illustrates test methods for measurement of these qualities.

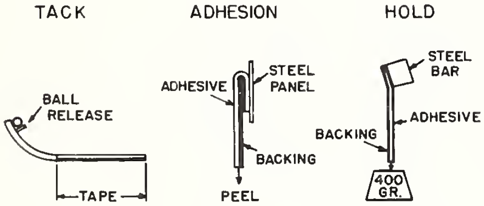

Figure 2.--Testing of pressure-sensitive tapes.

Tack has been defined and measured in many ways, but essentially every method of measuring this elusive quality is an attempt to assign an objective rating to the subjective feeling of "stickiness." Tack is that property of an adhesive which permits it to form an instantaneous bond with a minimum of pressure. At Newport, we have adopted a rolling-ball test, in which a small stainless-steel ball is rolled down an incline from a standard height and then is guided onto a horizontal strip of the adhesive tape. The distance rolled by the ball before being stopped by the drag of the adhesive is a measurement of the tack. The ratio of height dropped to distance rolled becomes our "Tack Value."

Adhesion of a pressure-sensitive tape may be defined as the ability to resist removal from the surface to which applied by lifting or peeling, as opposed to slipping or smearing which is a function of cohesion. Adhesion is measured as the force required to peel back, at an angle of 180°, a 1-inch wide strip of tape from a standard surface. Cohesion, or resistance to shear, is a familiar term requiring little explanation. As applied to adhesive tapes, cohesion of the adhesive must be sufficiently great to permit clean removal not only while being unwound from the roll, but also from a surface after use, and to prevent slippage in use due to adhesive flow. Since practically all uses of tape involve some force tending to lift the adhesive from the surface, we have adopted a 20° hold test to more closely duplicate end-use conditions. This test method measures the length of time that a half- by half-inch area of tape, adhered to a bar at an angle of 20° from the vertical, will support a given weight.

To possess tack, the adhesive must wet the surface of the adherend and must be sufficiently deformable to flow out on the surface and form an intimate contact with practically the entire area of contact. Certain resins enhance tack by plasticizing and softening the rubber to increase flow and instantaneous deformability of the adhesive. Such resins also reduce the cohesive strength, since shear resistance is dependent on minimum cold flow. These two characteristics, tack and shear resistance, may be controlled to some extent by other methods as well, so that the two are not as mutually incompatible as they would appear.

Many theories have been advanced to explain the mechanism of adhesion, no one of which appears to be completely satisfactory. Suffice it to say here, that adhesion has been shown to result from molecular forces between adhesive and adherent when the two are brought into close contact, on the order of fractions of one-millionth of an inch.

Surprisingly, these three basic properties of a pressure-sensitive adhesive appear to be mutually independent. That is, adhesives may be designed with high tack and little adhesion, as with removable paper labels used for temporary price markers, or with high tack and high hold, as in some fiber reinforced strapping tapes. Similarly, there are examples of practically all possible variations of the 3 properties in the tapes now on the market.

Our tests have shown that each type of resin modifies the adhesive properties in a distinctive manner. Indeed, the differences are as distinctive as fingerprints, and only slightly more predictable. Further, it has been found that seldom does a resin impart optimum tack at the same resin loading required for best hold strength. Fortunately, the adhesive chemist is not restricted to one tackifier; he may use various natural and synthetic oils to plasticize the mix to aid tack, and usually will use combinations of 2 or more resins so that each may contribute its proportionate share to adhesion and tack.

The composition of pressure-sensitive adhesives vary within rather narrow limits. For each 100 pounds of rubber, the tackifying resin will normally range from 70 to about 100 pounds, while the adhesive will contain less than 15 pounds of a plasticizing oil. Where transparency is not a requirement, inert fillers are often used up to a maximum of about 60 pounds per hundred of rubber. In the aggregate, these quantities represent a minor, but appreciable, share of the naval stores output. The Department of Agriculture estimates this year's consumption of rosin and rosin derivatives in pressure-sensitive adhesives at about 7, 300, 000 lb., while from 88 million to 120 million pounds are used in all classes of adhesives.

In our resin evaluation program, we normally evaluate only rubber-resin combinations, eliminating the other additives that might complicate results. And, since we are interested only in that component of tack and adhesion contributed by the resin, the rubber used is broken down mechanically only enough to be soluble, at which point, it has no tack or adhesive characteristics of itself.

Aging stability of a pressure-sensitive adhesive depends to some extent on the stability of rubber and the tackifying resin, although many formulators believe that the antioxidant protection of the rubber itself is the controlling factor in shelf life. Resin stability ideally would include no change on aging in color or compatibility with rubber due to chemical change caused by oxidation or the action of ultraviolet light. Unfortunately, such an ideal rubber tackifier has yet to be discovered. Among the available effective tackifiers, however, the polyterpenes appear to be least affected by long term aging.

The polyterpene resins have a very pale initial color which shows little or no darkening with age, less than one-tenth per cent weight increase in 1 month under pure oxygen, no discernible change in compatibility with rubber after 1 year's storage, and good resistance to ultraviolet light. This class of tackifiers has the additional advantage of a wide range of properties, dependent on average molecular weight. Polyterpenes of lower molecular weight are excellent plasticizers, increasing tack of adhesives, while higher molecular weight polyterpenes have superior adhesion and reinforcing properties.

NIREZ polyterpene resins are manufactured from whole turpentine, whereas many competitive polyterpenes are prepared from the b-pinene fraction. Figure 3 compares a representative NIREZ polyterpene resin with the $\beta$-pinene based resin of equivalent softening point in natural rubber adhesives. The lower curves show that NIREZ imparts substantially greater tack than does the $\beta$-pinene resin, presumably due to a greater degree of compatibility with rubber. The center curves indicate that NIREZ resin, as compared to its counterpart, gives a slightly reduced adhesion at the same resin concentrations, while the upper curves show the two resin types to give completely different patterns of hold strength. The lower peel adhesion is a minor matter to the adhesive formulator; a 5 percent increase in NIREZ content will equalize adhesion with no adverse side effects in most cases. The tremendous sales growth of the NIREZ polyterpene series of resins is evidence that the excellent aging stability combined with superior tackifying

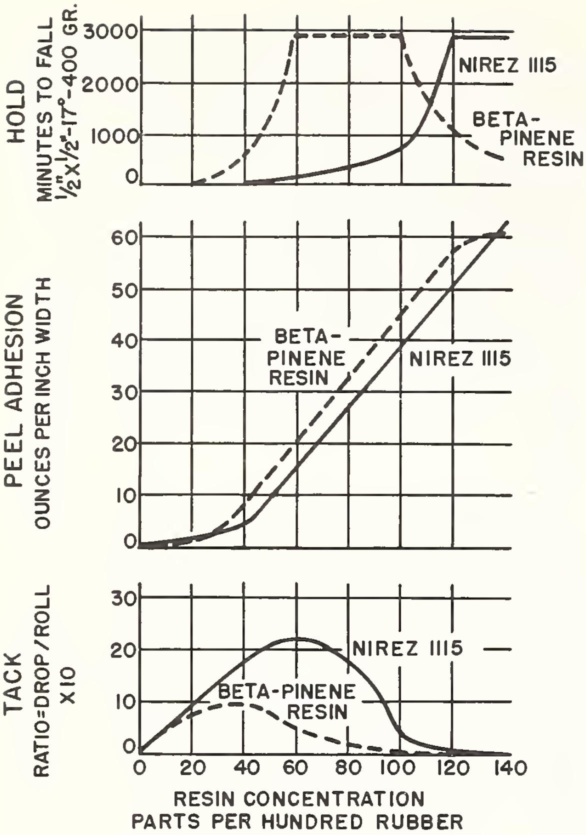

Figure 3.--Adhesive characteristics, polyterpene resin - natural rubber

effectiveness is recognized by the adhesive companies.

We have already mentioned the shelf stability of the adhesive, with emphasis on the resin additive. Of equal or even greater importance are the aging characteristics of the basic rubber in the adhesive. Natural rubber ages comparatively rapidly, and a 1 year shelf life for tape is considered a standard maximum for purposes of guaranteed performance. Deterioration of rubber is evidenced by a lengthy period of reversion during which the rubber becomes progressively softer and more gummy. Continued aging will cause the gummy rubber to again change, this time becoming hard and brittle. Use of an effective antioxidant will prolong the usable life of an unvulcanized rubber adhesive, and this is always used. Styrene-butadiene rubber, known as SBR, deteriorates by becoming harder and more brittle without first going through a gummy stage. For this reason, many pressure-sensitive adhesives utilize a mixture of natural and SBR rubbers; the increasing hardness of the SBR counteracts to some extent the increasing softness of the natural, and thus tends to prolong the life of the adhesive. Thus, it is essential for a tackifying resin to be effective not only in natural rubber, but also in mixes containing SBR. This requirement sometimes presents problems, because the two elastomers, although quite compatible with each other, have radically differing chemical structures and thus different resin compatibilities.

Figure 4 compares the adhesive characteristics of NIREZ 1115, softening point 115° C., with a $\beta$-pinene resin of comparable softening point in a 50-50 mixture of natural and SBR rubbers. In this mixed rubber, the higher compatibility of the resin based on whole turpentine, the NIREZ 1115, is striking. Its greater compatibility results in improved adhesive characteristics at practically all concentrations.

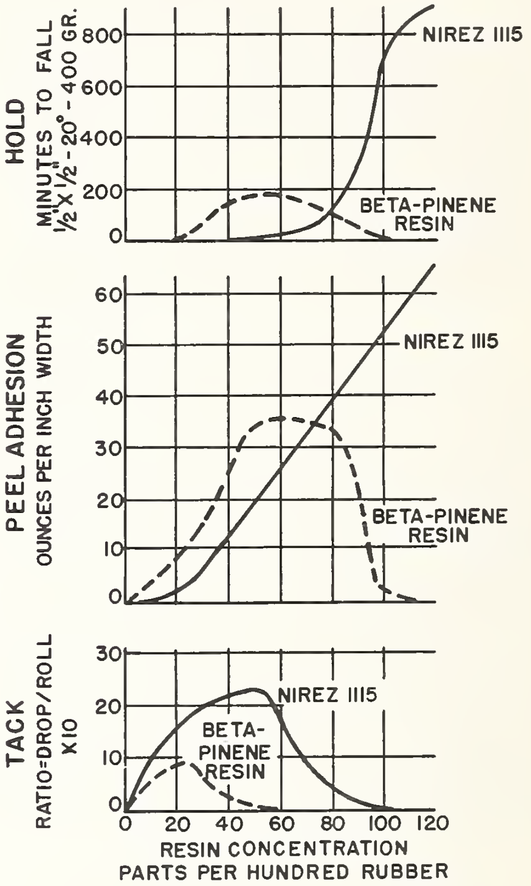

Figure 4.--Adhesive characteristics, polyterpene resin - 50:50 NAT:SBR

It is apparent that each resin must be evaluated individually in the elastomer combination to be used by the customer. Few general predictions can be made concerning the tackifying properties of other types of any resin in any elastomer, and even excellent tackifying effectiveness in one elastomer does not guarantee the same excellent properites of other types of synthetic rubber. For instance, although the NIREZ polyterpenes have been found to be superior adhesive resins when used with natural and most synthetic rubbers, the use of this series of resins with Neoprene is not recommended.

Newport has increased its research efforts in the field of adhesives in the firm belief that the usage of rosin and turpentine based resins will continue to grow. Many petroleum resins are being advanced as potential adhesive additives. An expanded program of research and technical service will be needed to maintain the superiority of naval stores products. Such a program is considered essential if the naval stores industry is to achieve its full potential in the expanding usage of rubber-based adhesives in the packaging and consumer market of tomorrow.

# INVESTIGATIONS ESTABLISHING THE SAFETY OF ROSIN PRODUCTS FOR FOOD PACKAGING APPLICATIONS

by

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Webster defines rosin as a resin obtained from turpentine by distillation, whose uses are numerous and well-known. Frankly, this is a poor definition, but I must agree that its uses are numerous and certainly well-known to this audience.

Noteworthy in its absence from this definition is any comment to the effect that rosin is safe. I think all of us knew this years ago, but in 1958 Congress declared rosin as a "poisonous and deleterious substance." This is not stated with cynicism, but with an understanding of a basic change in thinking by society--as reflected by Congress--on matters of public health. Prior to the last 10 years the average American was satisfied that adequate protection of the public was provided by laws that authorized the Government to prevent further sale of a product which could be proven to be unsafe--policing laws. However, with the advent of chronic toxicity, the agument was advanced that by the time the Government could prove such a case, irresponsible action on the part of a manufacturer could do irreparable damage to the public. As a consequence, in the field of public health we have started a shift to licensing laws--those which assume everything to be unsafe until proven otherwise to the satisfaction of the government.

I say we have started on this shift to licensing laws, because we have, in fact, only started. Drugs, pesticides, and food additives including packaging chemicals have come under this form of legislation. It is safe to predict that cosmetics will soon be covered by similar legislation, as well as all other environmental chemicals, including water and air pollutants, household substances, and natural food stuffs. The aim is to eliminate everything from our environment which might contribute to chronic, debilitating disease.

It is in this frame of reference that rosin was suspect, not because of any positive data on hazard, but the absence of data on safety from prolonged exposure.

Shortly after the Food Additives Amendment was passed, Hercules and several other rosin producers requested an opinion of the Food and Drug Administration on the safety of rosin and rosin-based products. We were informed that they could not consider them safe for the many extensive and diversified uses they enjoy without the conventional long term, 2-year chronic feeding studies in rats and dogs, and evidence based on these studies that they were safe to animals at 100 times the level in the diet of man.

I am certain I need not point out that this opinion presented Hercules with a major policy decision. Because of the vast number of products involved and their variety of uses, could we do the job on our products or would our customers have to do it? Our first step was to contact as many of our customers as possible and determine which products were most important to them and how they were used. Without this cooperation of our customers we could not have made an intelligent decision on the importance of the products nor could we have designed proper experiments to cover their uses.

Of our more than 70 rosin products, we concluded that 34 of these were used in sufficient volume by our chewing gum, flavor extract, paper, adhesive, cellophane, and coating customers to justify the expense involved in conducting these studies. The remainder did not. We also concluded that with only rare exception our customers could not justify the expense on the basis of his individual use of these products. Consequently, the inevitable decision was made that Hercules would undertake the project.

Our next step, quite understandably, was an evaluation of the need for extensive toxicological studies on all 34 of these products. Simple arithmetic of a minimum price of $50,000 per compound times 34 told us we faced an expenditure of 1-3/4 million dollars just for animal studies. Based on various analytical data on composition, we were able to design a more limited program that we believed would properly evaluate safety and yet avoid unnecessary duplication. This program was presented to the Food and Drug Administration and accepted in advance. It is this program that was announced several years ago, and which I will describe.

Let me start by explaining our thesis. We proposed to the Food and Drug that 2-year chronic studies in two species would be necessary only for those rosin products which had basically different resin acid components, and that 90-day subacute studies in one species would be adequate for the simpler derivatives (salts, esters, and addition products) provided these confirmed no greater toxicity than the parent rosin. The Food and Drug Administration agreed, except that products of different neutral components would also require 2-year studies.

The types of rosin products which were selected for both types of investigation are shown on the first two figures along with some of the types of products which were not investigated. The first of these tables shows the basic rosins and modified rosins.

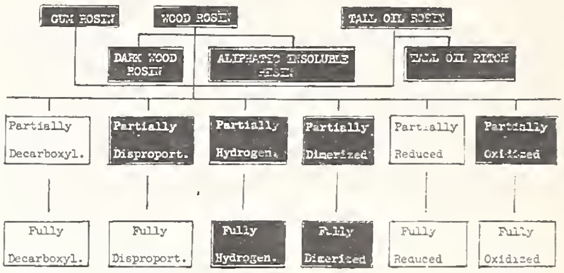

Figure 1.--Basic rosins and modified rosins.

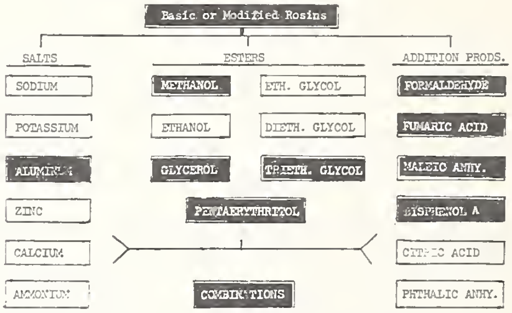

Figure 2.--Rosin derivatives.

The darkened blocks indicate those which were selected for study; no studies were conconducted on the others.

Gum Rosin was selected for its traditional importance to the paper industry and received the full 2-year study.

Wood Rosin, although it contained approximately the same resin acid composition as gum rosin, was fed for 2 years because the neutral fractions was different.

Tall Oil Rosin was also fed for 2 years because it contains a different neutral fraction than the other two sources.

Dark Wood Rosin and the aliphatic insoluble resin (Vinsol) were fed for 2 years because they contain different resins and resin acids which are partially oxidized.

Partially Disproportionated Rosin (Resin 731D) was fed for 2 years because it contains far more dehydroabietic acid than the other resins and a different neutral fraction.

Partially Hydrogenated Rosin (Staybelite) was fed for 2 years because it contained a very high level of dihydroabietic acid and a different neutral fraction.

Fully Hydrogenated Rosin (Foral) received similar long-term examinations because of its high content of tetrahydroabietic acid and also a different neutral fraction, due to different catalysts and reaction conditions.

Fully Dimerized Rosin (Dymerex) was fed for 2 years because of its very high dimer content and different neutrals.

Partially Dimerized Rosin (Poly-pale), although containing less dimer than the fully dimerized product, contains somewhat different neutrals and required the full 2 year examination.

Partially Oxidized Rosin is not a specific commercial product of Hercules, but is included in the figure to indicate that the partial oxidation was investigated indirectly by the feeding of dark wood rosin, whereas extensive oxidation has not been studied.

Figure 2 shows the major types of rosin salts, esters, and addition products. The shaded ones only were selected for animal feeding studies. As can be seen, different types of reaction products were studied. However, because many combinations of these reaction products are commercially important, a total of 24 products were fed for 90 days. For example, the glycerol ester of wood rosin, partially hydrogenated, partially dimerized, and fully dimerized were all fed. Likewise, the pentaerythritol ester of wood rosin and the pentaerythritol ester of maleic modified wood rosin were both fed.

In addition to the 24 subacute studies, we were required by the Food and Drug Administration to feed one of these derivatives for 2 years to both species to provide assurance that the mild reaction conditions did not alter the long-term toxicity of the neutrals. For this, we selected the Pentaerythritol ester of wood rosin (Pentalyn A). While we are on the subject of the feeding studies, let me briefly describe the design of these experiments and the results, before I describe the migration studies on these products.

Table 1 shows the basic design of our 90-day subacute studies. As can be seen, five dietary levels were selected for each of the basic rosins and each of the rosin derivatives. Because it was impossible to initiate all of these studies on the same day, 14 control groups were employed. As you can see, each of the 34 products was fed to 100 rats equally divided, 10 of each sex, between 5 dietary levels ranging from 0.01 percent and 5 percent.

Table 1. --Design of subacute studies

| Dietary levels (pct.) | No. of rats (per product) |
|---|---|
| 5.0 | 20 |
| 1.0 | 20 |
| .2 | 20 |
| .05 | 20 |
| .01 | 20 |
| Controls | 20 x 14 |
| Total 3,080 | |

Table 2 shows the basic design of the 2-year chronic studies. All of the basic rosins were fed at two dietary levels--1.0 and 0.05 percent. Three were fed also at the dietary level of 0.2 percent. The rosin ester, Pentalyn A, was fed only at the level of 0.05 percent. Four control groups of rats and two control groups of dogs were employed. Each group consisted of 30 male and 30 female rats, and 3 male and 3 female dogs. All of these experimental animal studies were conducted and designed by Hercules,

Table 2. --Design of chronic studies

| Dietary levels (pct.) | No. of rats per product | No. of dogs per product |
|---|---|---|
| 1.0 | 60 | 6 |
| .2 | 60 | - |
| .05 | 60 | 6 |
| Controls | 60 x 4 | 6 x 2 |
| Total | 1,680 | 138 |

with advice from the Food and Drug Administration, but were conducted under contract by the Industrial Bio-Test Laboratories, of Northbrook, Ill.

Table 3 is an attempt to itemize the most significant toxic effects which were noted in examination of almost 5,000 rats and 138 dogs. Not listed are the thousands of examinations which were made and which revealed normal results, including, for example, hematology, blood chemistry, liver and kidney function tests, urine chemistry, tumor incidence, and histologic examination of more than 20 organs and tissues. Very briefly, with most of the basic rosins, but with only a few derivatives, the animals died on the 5-percent dietary levels. No mortality occurred with any of the rosin products at the 1-percent dietary level. Growth was impaired at the 5 percent level with all of the basic rosins and a few of the derivatives. At the 1-percent level most of the rosins impaired growth but only a few of the derivatives. At 0.2 percent no growth effects were observed with any of the products. The difference in growth and mortality between the basic rosins and the derivatives was concluded to be due to the greater free acidity of the basic rosins, which caused intestinal irritation and food refusal.

Table 3.--General toxicological effects

| Item | Feeding level (pct.) | Basic and Modified rosins | Derivatives of rosin |
|---|---|---|---|
| Mortality | 5 | Most | Few |
| | 1 | None | None |
| Growth | 5 | All | Few |
| | 1 | Most | Few |
| | 0.2 | None | None |
| Organ wts. | 5 | All | All |
| | 1 | Most | Most |
| | 0.2 | None | None |
| Histopath. | 5 | Few | Few |
| | 1 | None | None |

Effects on organ weights were generally restricted to the liver, except for an effect on the kidneys and testes by a few types of rosins. All of the products produced marked liver enlargement at the 5-percent level, and most of the products caused some degree of enlargement at the 1-percent level in both species. No organ weight effects were observed at the 0.2 percent level. Histopathologic changes were present mostly in the liver, with the few exceptions noted above, and were restricted to the 5-percent dietary level.

The feeding tests have demonstrated that the "no effect" or safe dietary level of the products selected for these toxicological tests is 2,000 p.p.m. for some and 10,000 p.p.m. for others.

Now, let us shift our discussion to the other phase of our investigation that was designed to evaluate the quantity of rosin products contributed to the human diet from all the various uses which rosins enjoy. As many of you realize, we have subscribed to a philosophy in this country, which has recently been endorsed by the World Health Organization and Food and Agricultural Organization of the United Nations, that we should not permit food additives in man's diet unless it is safe to experimental animals at 100 times the level contemplated in the human diet. The original basis for this conservativeness is cited as a device to compensate for our lack of precise means of predicting the effect of a compound on the most sensitive human. I like to call it an "ignorance factor," but more traditionally it is called a "margin of safety." The figure is based on the assumption that man is 10 times as sensitive as the experimental animals and the most sensitive human is 10 times as sensitive as the average. Experience has taught us that this factor is overly conservative.

To determine whether a 100-fold margin of safety existed for the rosin products, information was required on the amount contributed to food from the use of these products as sizing agents, tackifiers in adhesives, plasticizers in wax coatings, modifiers in coatings, and masticatory substances in chewing gum--the major uses in which human food are associated.

Usual methods of chemical analysis were not satisfactory or adequate for most of these studies for obvious reasons; therefore, we resorted to the use of radioactive techniques. Time did not permit us to grow pine trees in a radioactive carbon dioxide atmosphere and collect the radioactive rosin. However, after many preliminary experiments, we developed a procedure to introduce tritium, radioactive hydrogen, into the rosin molecule by the Wilzbach random-tagging procedure and thus were able to prepare many of these products to contain a uniform "tag" on all components including the neutral fractions. For other rosin products, as rosin esters, we were able to esterify the rosin with $C^{14}$ tagged alcohol.

Rather than devote the entire time allowed to a discussion of the details of how these experiments were conducted, I believe it would be more appropriate to show you the results of a few of our migration experiments. In all of these experiments, we were again indebted to many of our customers who supplied us with detailed information on formulation, and in some cases, prepared the finished formulation so that our migration studies would accurately evaluate the degree of migration.

In the next series of tables I have selected representative data merely to give an indication of the degree of migration. Table 4 shows the typical migration of rosin size to food. In this table, I have shown the analyses in foods which have been stored for reasonable times at reasonable temperatures in contact with typical commercial paper containing 2.5 percent radioactive rosin size. It is obvious that migration is a function of temperature and degree of fat in the food. In table 5 I have summarized data for aqueous and fatty foods at refrigerator and room temperatures for a commercial nitrocellulose lacquer coating on paper, containing 20 percent Hercolyn D in the coating. This particular experiment was conducted both with tritium tagged Hercolyn D and $C^{14}$ tagged Hercolyn D, ($C^{14}$ in the methanol radical). Again migration to fatty foods is the most significant.

Table 4. --Typical migration of rosin size 1/

| Type food | Temp. | Time | Migration |
|---|---|---|---|
| | | Days | p.p.m. |
| Ice cream | Freezer | 28 | .1 |
| Green beans | Freezer | 28 | .1 |
| Chicken | Refrig. | 3 | 3.2 |
| Sausage | Refrig. | 5 | 52.7 |
| Butter | Refrig. | 7 | 10.7 |
| "Puffedrice" | Room | 7 | 4.8 |
| Sugar | Room | 7 | .8 |

1/ 2.5 percent pale rosin size in paper.

Table 5. --Typical migration of rosin ester from lacquer coating 1/

| Type food | Temp. | Time | Migration |
|---|---|---|---|
| | | Days | P.p.m. |
| Aqueous | Refrig. | 14 | .1 |
| Fatty | Refrig. | 14 | 47 |
| Aqueous | Room | 14 | .8 |
| Fatty | Room | 14 | 72 |

1/ Containing 20-percent Hercolyn D,

Table 6 shows the migration from paper with a wax coating that has been modified with 10 percent Staybelite Ester 10. No fatty foods were studied because such foods are not ordinarily packaged in this type of paper. These data reveal the marked effect of temperature on the degree migration.

Table 6. --Typical migration of rosin ester from wax coatings 1/

| Type food | Temp. | Time | Migration |
|---|---|---|---|
| | | Days | P.p.m. |
| Aqueous | Refrig. | 14 | 1.4 |
| Aqueous | Room | 14 | 3.0 |
| Aqueous | Warehouse | 14 | 11.6 |

1/ Containing 10-percent Staybelite Ester 10.

Table 7 shows similar data for aqueous and fatty food exposed to paper containing no radioactive rosin except in the adhesive used for sealing edges. The adhesive contained 50 percent Staybelite Ester 10 as the tackifying agent. Only 5 percent of the adhesive was in direct contact with the food. High temperature and fatty foods result in the highest level of migration.

Table 7. --Typical migration of rosin ester from adhesives 1/

| Type food | Temp. | Time | Migration |
|---|---|---|---|
| | | Days | P.p.m. |
| Aqueous | Refrig. | 7 | .6 |
| Fatty | Refrig. | 7 | 13 |
| Aqueous | Room | 7 | 1.2 |
| Fatty | Room | 7 | 13 |

1/ Containing 50-percent Staybelite Ester 10; 95-percent overlap.

Table 8 shows the migration, or extraction, or a rosin ester from chewing gum when

Table 8. --Typical migration from chewing gum[1]

| Mastication | Time | Migration |
|---|---|---|
| | Hrs. | P. p. m. to total diet |
| Machine | 1 | .7 |
| | 5 | .9 |
| Human | 1 | .3 |
| | 2 | .4 |

[1] Gum base containing 20-percent Hercolyn D.

used as a softening agent in the masticatory substance. This particular gum base contained 20 percent Hercolyn D and the gum base represented 20 percent of the finished chewing gum. The migration figures are calculated on a total diet basis (1 kilogram of dry food per day) to permit comparison with other migration data and assuming a maximum chewing of 1 pack a day. The data show a low level of migration both from the mastication machine, which was a laboratory double-armed kneader, and from actual human mastication of the radioactive gum and expectoration of saliva.

Table 9 summarizes all of the migration studies and shows the average migration to the two categories of foods from the five major applications of rosin products.

Table 9. --Average migration of rosin products (Typical conditions of use and storage)

| Application | Aqueous foods | Fatty foods |
|---|---|---|
| | P. p. m. | P. p. m. |
| Rosin sizing | 1.5 | 32 |
| Lacquer coatings | .5 | 24 |
| Wax coatings | 1.0 | -- |
| Adhesives | .4 | 5 |
| Chewing gum | .5 | -- |

The facts are now available on the degree of migration to food resulting from the use of rosin products. The facts are also available on the toxicity of these products to experimental animals. Table 10 shows the comparison of toxicity with our best estimate of the amount of rosin contributed to the diet of humans. A minimum of a 200-fold margin of safety exists.

Table 10. --Comparison of migration results with toxicity

| | |
|---|---|
| Migration to total diet of man | 5 to 10 p. p. m. |
| Safe level in total diet of rats and dogs | 2,000 to 10,000 p. p. m. |

I have tried to summarize the investigations Hercules has conducted to demonstrate the safety of rosin products in several of their major uses. These data have been submitted to the Food and Drug Administration and have served as the major basis for the proposed regulation permitting their uses in these applications. We are confident that the Food and Drug Administration will agree that the use of these products involves no risk to the health of the consumer.

## SESSION IV - PANEL DISCUSSION

F. R. Gates, Chairman

## CONCLUSION OF CONFERENCE

The Conference concluded with a panel discussion on problems facing the naval stores industry. The session was chaired by F. R. Gates, Union Bag-Camp Paper Corp., New York, N. Y. Members of the panel and the areas they covered are: C. H. Horst, Guignon & Green, Inc., New York, N. Y., "Marketing;" E. L. Patton, The Langdale Co., Valdosta, Ga., "Manufacturing;" E. G. Crum, Hercules Powder Co., Wilmington, Del., "Utilization;" G. W. Varn, Varn Trading Co., Jacksonville, Fla., and J. S. Laws, Filtered Rosin Products Co., Baxley, Ga., "Quality and Raw Materials;" and J. R. Durland, Monsanto Chemical Co., St. Louis, Mo., "Research."

Judge Harley Langdale, President of the American Turpentine Farmers Association, in his closing remarks thanked the participants; and, in behalf of the naval stores industry, expressed appreciation for the government research program.

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## ATTENDANCE OF PERSONNEL FROM THE SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION FOR AT LEAST ONE SESSION OF THE MEETING

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